OF

Department of Energy
Oak Ridge Operations
Weldon Spring Site
Remedial Action Project Office
Route 2, Highway 94 South
St. Charles, Missouri 63303

August 7, 1987

ADDRESSEES

HYDROGEOLOGICAL CHARACTERIZATION REPORT

Enclosed are copies of the final report for the Hydrogeological Characterization Report for Weldon Spring Chemical Plant, Weldon Spring, Missouri.

Please distribute as appropriate throughout your agency.

Sincerely,

R. R. Nelson

R. R. Nelson
Project Manager
Weldon Spring Site
Remedial Action Project

CE-541:Lawver

Enclosures

DOE/OR/20722-137

Formerly Utilized Sites Remedial Action Program (FUSRAP)
Contract No. DE-AC05-81OR20722

HYDROGEOLOGICAL CHARACTERIZATION REPORT FOR WELDON SPRING CHEMICAL PLANT

Weldon Spring, Missouri

July 1987

Bechtel National, Inc.

DOE/OR/20722-137

HYDROGEOLOGICAL CHARACTERIZATION REPORT FOR THE WELDON SPRING CHEMICAL PLANT

JULY 1987

Prepared for

UNITED STATES DEPARTMENT OF ENERGY

OAK RIDGE OPERATIONS OFFICE

Under Contract No. DE-AC05-81OR20722

By

Bechtel National, Inc.

Oak Ridge, Tennessee

Bechtel Job No. 14501

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ACRONYMS

AEC	Atomic Energy Commission
BNI	Bechtel National, Inc.
BQL	Below Method Quantitation Limit
CEP	Controls for Environmental Pollution, Inc.
CHDP	Constant Head Double Packer Pressure Test
CHSP	Constant Head Single Packer Pressure Test
DA	Department of the Army
DOE	Department of Energy
EM	Electromagnetic Terrain Conductivity (survey)
FH	Falling Head Test
FUSRAP	Formerly Utilized Sites Remedial Action Program
GMW	Groundwater Monitoring Well
M-K	Morrison-Knudeson
MODNR	Missouri Department of Natural Resources
ORP	Oxidation Reduction Potential (REDOX)
SFMP	Surplus Facilities Management Program
TMA	Thermo Analytical
TNT	Trinitrotoluene
USGS	United States Geological Survey
WSCP	Weldon Spring Chemical Plant
WSSRAP	Weldon Spring Site Remedial Action Project
WSOW	Weldon Spring Ordnance Works

ABBREVIATIONS

cm	centimeter
cm^2	square centimeter
cmp	corrugated metal pipe
cm/s	centimeter per second
Fm	Formation
ft	foot
ft^2	square foot
ft^3	cubic foot
g	grams; gravity
gal	gallon
gpm	gallons per minute
in.	inch
l	liter
lb	pound
lb/ft^3	pounds per cubic foot
l/s	liters per second
L/T	ratio of length to time
m	meter
m^2	square meter
m^3	cubic meter
meq	milliequivalents
mgd	million gallons per day
mg/l	milligrams per liter
mi	mile
ml	milliliter
mmhos/m	millimhos per meter
mv	millivolts
pCi/g	picocuries per gram
pCi/l	picocuries per liter
$pCi/m^2/s$	picocuries per square meter per second
pCi/m^3	picocuries per cubic meter
pCi/ml	picocuries per milliliter
ppb	parts per billion
psi	pounds per square inch

ABBREVIATIONS
(continued)

psig	pounds per square inch-gauge
PVC	polyvinylchloride
s	second
yd^3	cubic yards
yr	year

1.0 INTRODUCTION

The Weldon Spring Chemical Plant (WSCP) is located in St. Charles County, Missouri, approximately 20 mi west of St. Louis, Missouri. Figure 1-1 presents the general location of the site and its relationship to major geographical features and population centers. A detailed plan of the WSCP's major buildings and features, including the raffinate pits, is provided in Figure 1-2.

In 1941, the U.S. Department of the Army (DA) acquired the site and surrounding areas for construction of the Weldon Spring Ordnance Works (WSOW). The WSOW operated from 1941 through 1944 and was engaged in the manufacture of trinitrotoluene (TNT) and related compounds. In 1946, the WSOW was declared surplus land, and parcels were transferred to various federal, state, and local agencies or sold to private concerns.

In 1956, the Atomic Energy Commission (AEC) acquired approximately 220 acres of the original WSOW from the DA for use as a uranium feed materials plant. The plant was operated as an integrated facility for the conversion of uranium ore concentrates and recycled scrap to pure uranium trioxide, intermediate compounds, and uranium metal. A relatively small amount of thorium was also processed. The feed materials plant ceased operations in 1966. During the plant operating period, four pits were excavated for storage of raffinates from the plant. Following the shutdown of the feed materials plant in 1966, the AEC returned the facility to the DA in 1967 for planned use as a defoliant production plant [to be known as the Weldon Spring Chemical Plant (WSCP)]. The DA started removing equipment and decontaminating the buildings in 1968. The defoliant project was cancelled in 1969 before any herbicide was produced. The DA retained the responsibility for the land and the facilities at the WSCP, but the tract encompassing the raffinate pits was transferred back to the AEC.

In November 1984, the Department of Energy (DOE) was directed by the Office of Management and Budget to assume responsibility for the WSCP from the DA. This transfer of responsibility occurred on October 1, 1985. The chemical plant was transferred from the DA to DOE for administration under its Formerly Utilized Sites Remedial Action Program (FUSRAP)/Surplus Facilities Management Program (SFMP) with caretaker support supplied by Bechtel National, Inc. (BNI). In 1986, the site (chemical plant and raffinate pits) became a separate remedial action project known as the Weldon Spring Site Remedial Action Project (WSSRAP) under a DOE contract with the M-K Ferguson Company.

This hydrogeological investigation is aimed at providing information for the siting of a disposal facility on the 220-acre site. The hydrogeological characterization plans and field work were completed by BNI during the spring, summer, and fall of 1986 under the FUSRAP/SFMP prior to the 1986 transition to the WSSRAP.

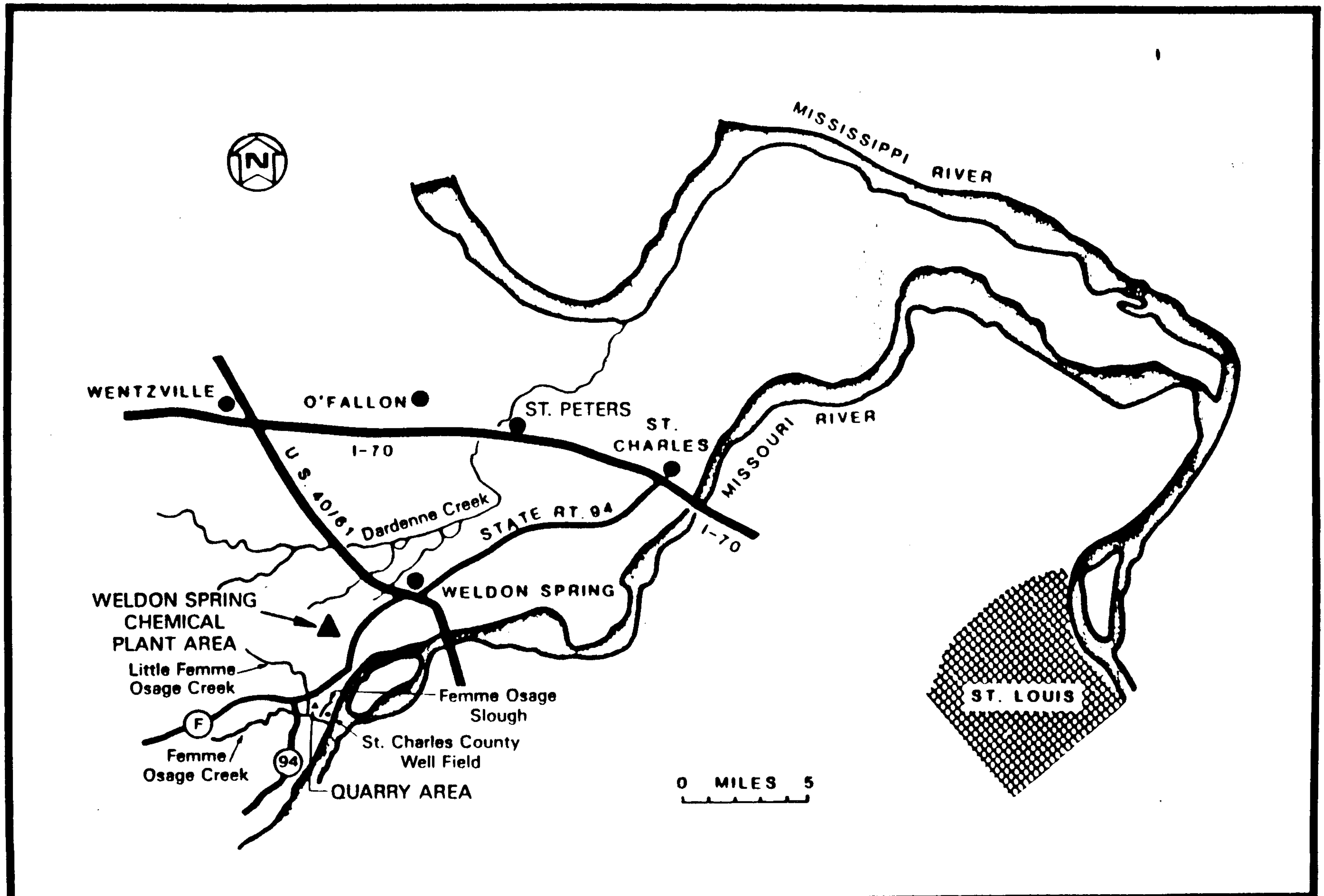


FIGURE 1-1 LOCATION OF WELDON SPRING CHEMICAL PLANT

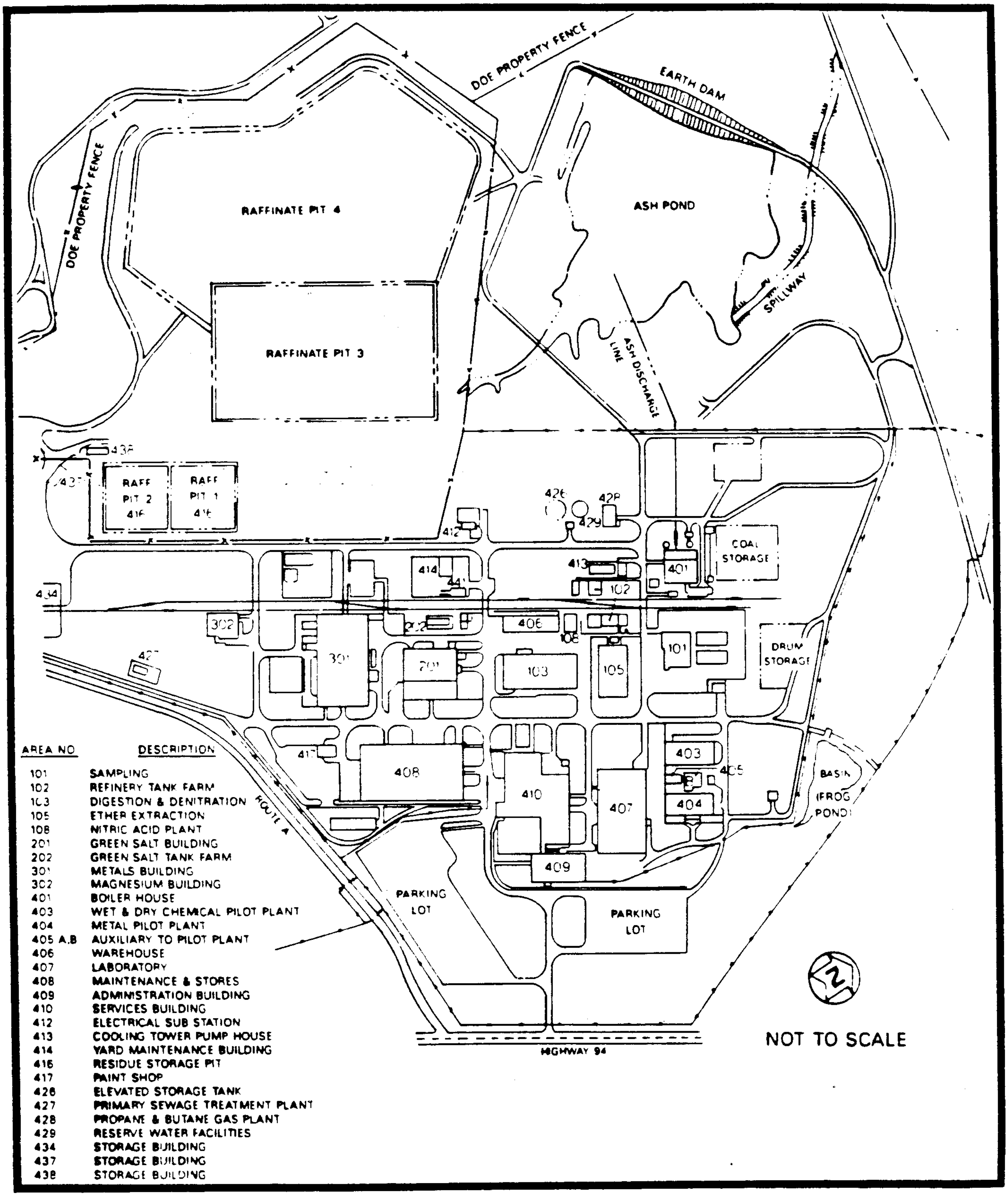


FIGURE 1-2 WELDON SPRING CHEMICAL PLANT AND RAFFINATE PITS (MAJOR BUILDINGS AND FEATURES)

2.0 PURPOSE AND SCOPE

2.1 PURPOSE

A hydrogeological characterization study was performed at the WSCP to meet two objectives:

- Provide a groundwater monitoring system to determine if contaminants from the site have degraded groundwater quality.
- Evaluate the site geology and hydrogeology for utilization of the site as a waste disposal facility.

2.2 SCOPE

The site investigation included geophysical surveys, trenching, borehole drilling and sampling, installing groundwater monitoring wells, laboratory soil property analyses, and groundwater sampling and chemical analyses.

3.0 PREVIOUS SITE INVESTIGATIONS

Site-specific geological and hydrogeological studies have been performed. These investigations include those by Fishel and Williams (1944), Roberts (1951), Lutzen (1967), Moylan and Elser (1967), the DA (1976), Lomenick (1982), Dean [1978, 1984 (two studies), and 1985], Berkeley Geosciences Associates (1984), and BNI (1984).

Fishel and Williams (Ref. 1) performed the first hydrogeological investigation of record, involving contamination of groundwater and surface waters by liquid wastes from the WSOW. This investigation concentrated on the migration of acid wash water and red water from the plant. The report concluded that the majority of the groundwater contamination resulted from surface runoff subsequently recharging bedrock and alluvial aquifers along Dardenne Creek. Roberts (Ref. 2) examined the site hydrogeological conditions prior to construction of the WSCP, for the AEC. This report focused primarily on providing baseline hydrogeological data and did not deal specifically with contaminant migration potential.

Lutzen (Ref. 3) evaluated seepage conditions at the raffinate pits and concluded that the low permeability of the soils would preclude any groundwater contamination by seepage from the pits. Moylan and Elser (Ref. 4) also evaluated the raffinate pits; although they found no evidence of seepage, they recommended installation of groundwater monitoring wells in the uppermost bedrock unit to allow early detection of groundwater contamination.

The DA (Ref. 5) evaluated hydrogeological conditions at the WSCP in its site assessment and concluded that vertical migration of contaminants would be minimal due to the low permeability of the soil. Dean (Ref. 6) pointed out that the DA data indicate the presence of a paleosink on the chemical plant site. He contended that this sink may act as conduit for contaminant migration to the groundwater system. He recommended that additional investigations be performed to evaluate potential contaminant migration pathways.

Lomenick (Ref. 7) evaluated the hydrogeological data for the raffinate pits area and indicated that no detectable quantities of radionuclides had migrated from the pit area, but he recommended additional borings and groundwater sampling to verify this conclusion. The Berkeley Geosciences investigation at the raffinate pits (Ref. 8) included the installation of seven groundwater monitoring wells placed to the top of bedrock. This study concluded that water in the raffinate pits is probably perched above the regional groundwater system and recommended that additional boreholes be drilled beneath the pits to allow evaluation of vertical seepage from the pits.

Dean (Refs. 9 - 11) performed dye tracing studies in the chemical plant area to determine the relationship between surface water and groundwater. The most significant finding of this investigation was that the drainageway from the plant ash pond was connected via the subsurface to the Burgermeister Spring area, a straight line subsurface flow distance of approximately 6,500 ft.

BNI (Ref. 12) performed a detailed geological investigation of the raffinate pits area. This investigation included geophysical surveys, trenching, drilling and sampling boreholes, installation of groundwater monitoring wells, and installation of piezometers. The finding of this investigation was that the raffinate pits site is suitable for long-term storage of residual radioactive materials.

4.0 REGIONAL GEOLOGY

Elements of regional geology applicable to the geological characterization of the site are stratigraphy, structural geology, and seismology.

4.1 STRATIGRAPHY

4.1.1 Consolidated Materials

Figure 4-1 presents a generalized description of geological formations in the Weldon Spring area.

The oldest formations of interest are the Ordovician age Champlanian series. This series includes the St. Peter Sandstone, the Joachim Dolomite, the Plattin Limestone, the Decorah Formation, and the Kimmswick Limestone. The St. Peter Sandstone is composed of fine- to medium-grained, massive-bedded, quartzose sandstone. Overlying the St. Peter Sandstone is the Joachim Dolomite, which is a thin- to thick-bedded dolomite which grades into a siltstone (Ref. 13). The Plattin Limestone overlies the Joachim and is a thin- to thick-bedded, microcrystalline to fine-grained limestone. Overlying the Plattin is the Decorah Formation, which is a thin-bedded argillaceous limestone with intercalcated calcareous shales. A thin bed of metabentonite separates the Plattin and Decorah Formations. The Kimmswick Limestone unconformably overlies the Decorah and is composed of thick-bedded, high-purity limestone with local concentrations of chert (Ref. 14).

Overlying the Kimmswick is the Ordovician age, Cincinnatian series Maquoketa Shale. This unit pinches out northeast of Weldon Spring (Ref. 13) and is probably not present beneath the site.

South and west of Weldon Spring, the Kimmswick Limestone is unconformably overlain by the Upper Devonian age Sulfur Spring Group. This group is represented by the Bushberg Sandstone member in the Weldon Spring area. The Bushberg Sandstone is a fine- to medium-grained quartzose sandstone with variable carbonate content (Ref. 14).

Unconformably overlying the Bushberg is the Early Mississippian age, Kinderhookian series Chouteau Formation. This formation is a thin-bedded limestone which contains a few shale partings and localized quantities of argillaceous material and chert (Ref. 14).

The Chouteau Formation is conformably overlain by the Mississippian age, Osagean series which includes the Fern Glen Limestone and the Burlington and Keokuk Limestones. The Fern Glen Limestone is a thin- to thick-bedded, crystalline to argillaceous limestone. Chert is common in this formation with occasional calcareous shale interbeds also occurring. The Burlington and Keokuk Formations are similar lithologically and have been grouped together by most investigators. These formations will hereinafter be referred to as the Burlington/Keokuk Formation. This formation is composed of limestone with abundant bedded and nodular chert. The limestone is very thin- to thick-bedded and crystalline, with grain sizes ranging from very fine to very coarse (Ref. 14).

Overlying the Osagean series are the Mississippian age, Meramecian series limestones which include the Warsaw Formation, the Salem Limestone, and the St. Louis Limestone. These units represent the stratigraphically youngest consolidated rocks in the Weldon Spring area. These units have been locally eroded away southwest of Weldon Spring (Ref. 13).

4.1.2 Unconsolidated Materials

Unconsolidated materials in the Weldon Spring area can be subdivided into five units:

- o Alluvial deposits
- o Aeolian deposits (loess)
- o Ferrelview Formation

- Glacial till
- Residuum

Alluvial deposits are primarily found in the Missouri and Mississippi River valleys and along major tributaries to these rivers. These deposits are typically composed of silt and clay of the Holocene epoch, underlain by sand and gravel of both the Holocene and Pleistocene epochs (Ref. 1). Thicknesses of the alluvial deposits range from a few feet to in excess of 100 ft along the Missouri River (Ref. 15).

Aeolian deposits are primarily loess (wind-deposited silt and clay) which was deposited during the Wisconsinan stage of the Pleistocene epoch. The loess deposits range from a slightly clayey silt to a silt and clay (approximately 50 percent of each). These deposits range from less than 5 ft to approximately 20 ft in thickness. The areal distribution of these deposits is typically limited to bluff tops and crests of divides (Ref. 16).

The Ferrelview Formation is a Pleistocene deposit composed of clayey silt. The preferred theory concerning the depositional environment for this unit is accumulation on a poorly drained till-plain surface. This unit is reported to range in thickness from 8 to 10 ft (Ref. 17). Since the Ferrelview Formation is related to the underlying glacial till, the distribution of the Ferrelview is also controlled by the areal distribution of the till.

Glacial till deposited during the Kansan stage of the Pleistocene epoch is present in the Weldon Spring area. The till is composed of clay, silt, sand, gravel, and cobble-sized particles. The glacial till has been subdivided into a clay till unit and a basal till unit based upon sand percentage and petrologic composition of the gravel/cobble fraction. The clay till unit is composed of clay with some sand, silt, and gravel. The gravel fraction is composed of quartz, chert, and igneous and metamorphic rocks. The presence of igneous and metamorphic rocks suggests a distal provenance for this till. The basal till unit is composed of chert cobbles in a sandy, clayey silt matrix. The gravel and cobble fractions of this unit are almost entirely chert. The abundance of chert suggests a proximal provenance for this till. The areal distribution of glacial till in the Weldon Spring area varies and depends on the bedrock surface topography and the extent of glaciation in the area. Thickness of the glacial till varies from 0 (in areas of rock outcrop) to approximately 45 ft (Ref. 12).

The residuum is material resulting from in situ weathering of bedrock. Much of the Weldon Spring area is underlain by Mississippian age limestones. The residuum developed on these rocks is typically reddish-brown gravelly clay. The composition and percentage of the gravel fraction varies with the rock unit on which the residuum is developed. The residuum thickness varies from less than 4 ft up to 20 ft (Ref. 16).

4.2 STRUCTURAL GEOLOGY

The rocks in the Weldon Spring area have a regional strike of N60°W with a regional dip of approximately 1/2° to the northeast. The regional dip is a result of flexure from the Ozark dome (Ref. 14). Several small flexures have been noted in the Weldon Spring area; the nearest to the site is the Eureka/House Springs anticline. This flexure is located approximately 4 mi southwest of the site and trends northwest-southeast (Ref. 13).

Roberts (Ref. 2) identified two major joint sets in the Weldon Spring area: one set trending between N30°E and N72°E and a second set trending between N30°W and N65°W. Krummel (Ref. 14) indicates that the joint planes are vertical or nearly vertical.

All of the investigations in the Weldon Spring area have indicated that no faulting is evident in the exposed bedrock units.

4.3 SEISMICITY

The site seismicity and design earthquake considerations for the Weldon Spring area were previously evaluated by BNI (Ref. 18). The following paragraphs and figures summarize the results of the evaluation.

The Weldon Spring area lies within the tectonically inactive Central Stable Region near its boundary with the Mississippi Embayment. The Mississippi Embayment contains tectonically active areas with several fault zones present, including the New Madrid seismic zone. Figure 4-2, based on data from the National Geophysical and Solar-Terrestrial Data Center (Ref. 19), is a plot of regional seismicity within 200 mi of Weldon Spring. The New Madrid seismic zone is clearly defined by the seismic activity cluster located along the southeastern tip of Missouri.

Probabilities of peak dynamic accelerations and intensities have been evaluated for the Missouri area by Algermissen and Perkins (Ref. 20). They calculated accelerations with a 10 percent expectation during a 50-yr period (approximately equivalent to 475-yr accelerations). The results of their calculations are shown on Figure 4-3. Interpolation between contours indicates that the Weldon Spring area would have a gravitational acceleration of approximately 0.07 g at this probability level.

In addition to peak dynamic acceleration, estimates of maximum site intensity and body wave magnitudes were made. Estimates of maximum potential intensity range from VII to VIII on the modified Mercalli intensity scale. These values imply body wave magnitudes of about 5.3 to 5.8.

SYSTEM	SERIES	STRATIGRAPHIC UNIT	DEPTH FROM GROUND LEVEL TO TOP OF FORMATION, IN FEET	TYPICAL THICKNESS, IN FEET	DESCRIPTION
QUATERNARY	HOLOCENE	ALLUVIUM	0	10-30	GRAVELLY, SILTY LOAM OVER OCCASIONALLY GRAVELLY, SILTY CLAY LOAM.
				100-110	SILTY LOAM, CLAY, AND SAND OVER SAND AND GRAVELLY SAND.
	PLEISTOCENE	LOESS AND GLACIAL DRIFT	0	5-30 30-60	SILTY CLAY, SILTY LOAM, CLAY, OR LOAM OVER RESIDUUM AND BEDROCK, OR BOTH.
PENNSYLVANIAN		UNDIFFERENTIATED	0-120	0	PARTLY SILTY RED SHALE WITH PURPLISH-RED TO LIGHT GRAY CLAY.
MISSISSIPPIAN	MERAMECIAN	ST. LOUIS LIMESTONE	0-120	70-75	LIMESTONE; WHITE TO LIGHT GRAY, LITHOGRAPHIC TO FINELY CRYSTALLINE, MEDIUM TO THICK-BEDDED. CONTAINS SOME SHALE.
		SALEM LIMESTONE	0-225	90-130	LIMESTONE; LIGHT GRAY TO WHITE, FINE TO COARSELY CRYSTALLINE, CROSS-BEDDED. SOME SILTSTONE AND SHALE IN LOWER PART.
		WARSAW FORMATION	0-345	70-90	CALCAREOUS SHALE; AND INTERBEDDED SHALY LIMESTONE. GRADES DOWNWARD TO SHALY DOLOMITIC LIMESTONE.
	OSAGEAN	KEOKUK AND BURLINGTON LIMESTONES	0-405	160-200	LIMESTONE; WHITE TO BLUISH-GRAY, MEDIUM TO COARSELY CRYSTALLINE, THICK-BEDDED. CHERTY.
		FERN GLEN LIMESTONE	0-500	50-70	LIMESTONE; YELLOW-BROWN, FINE-GRAINED, MEDIUM- TO THICK-BEDDED. CONTAINS APPRECIABLE CHERT.
	KINDERHOOKIAN	CHOUTEAU LIMESTONE	0-580	50-70	DOLOMITIC LIMESTONE; GRAY TO YELLOWISH-BROWN, FINE-GRAINED, THIN- TO MEDIUM-BEDDED.
DEVONIAN	UPPER	BUSHBERG SANDSTONE	0-625	5-15	QUARTZ SANDSTONE, REDDISH-BROWN, FINE- TO MEDIUM-GRAINED, FRIABLE.
		LOWER PART OF SULPHUR SPRING GROUP UNDIFFERENTIATED	0-625	35-40	CALCAREOUS SILTSTONE, AND SANDSTONE WITH OOLITIC LIMESTONE WITH SOME DARK, HARD, CARBONACEOUS SHALE.
ORDOVICIAN	CINCINNATIAN	MAQUOKETA SHALE	0-650	30-50	CALCAREOUS OR DOLOMITIC SHALE, TYPICALLY THINLY LAMINATED, SILTY, WITH SHALY LIMESTONE LENSES.
	CHAMPLAINIAN	KIMMSWICK LIMESTONE	0-710	90-100	LIMESTONE; WHITE TO LIGHT GRAY, COARSELY CRYSTALLINE, MEDIUM- TO THICK-BEDDED. CHERTY NEAR BASE.
		DECORAH FORMATION	0-810	30	INTERBEDDED GREEN AND YELLOW SHALE WITH THIN BEDS OF LIMESTONE.
		PLATTIN LIMESTONE	0-840	100-125	LIMESTONE; LIGHT TO DARK GRAY, FINELY CRYSTALLINE. THINLY BEDDED; WEATHERS WITH PITTED SURFACE.
		JOACHIM DOLOMITE	0-950	90-110	DOLOMITE; YELLOWISH-BROWN, SILTY, THIN- TO THICK-BEDDED. GRADES INTO SILTSTONE, SHALES COMMON.
		ST. PETER SANDSTONE	0-1070	120-150	QUARTZ SANDSTONE; YELLOWISH-WHITE TO WHITE, FINE- TO MEDIUM-GRAINED, MASSIVE-BEDDED.
		EVERTON FORMATION	0-850	0	SANDY DOLOMITE.
	CANADIAN	POWELL DOLOMITE	0-950	50-60	DOLOMITE, MEDIUM TO FINELY CRYSTALLINE, OFTEN SANDY, OCCASIONALLY CHERTY OR SHALY.
		COTTER DOLOMITE	0-1250	200-250	DOLOMITE; LIGHT GRAY TO LIGHT BROWN, MEDIUM TO FINELY CRYSTALLINE, CHERTY. ARGILLACEOUS, INTERBEDDED WITH GREEN SHALE.
		JEFFERSON CITY DOLOMITE	100-1500	160-180	DOLOMITE; LIGHT BROWN TO BROWN, MEDIUM TO FINELY CRYSTALLINE.
		ROUBIDOUX FORMATION	350-1700	150-170	DOLOMITIC SANDSTONE.
		GASCONADE DOLOMITE	500-1850	250	CHERTY DOLOMITE-GUNTER MEMBER IS ARENACEOUS DOLOMITE.
CAMBRIAN	UPPER	EMINENCE DOLOMITE	750-2100	200	DOLOMITE; MEDIUM- TO MASSIVELY BEDDED, LIGHT GRAY, MEDIUM- TO COARSE-GRAINED.
		POTOSI DOLOMITE	950-2250	100	DOLOMITE, MASSIVE, THICKLY BEDDED, MEDIUM- TO FINE-GRAINED. ABUNDANT QUARTZ DRUSE.
		DERBY AND DOE RUN DOLOMITES	1050-2350	150	DOLOMITE, THIN- TO MEDIUM-BEDDED ALTERNATING WITH THIN-BEDDED SILTSTONE AND SHALE.
		DAVIS FORMATION	1200-2500	170	CONTAINS SHALE, SILTSTONE, FINE-GRAINED SANDSTONE, DOLOMITE, AND LIMESTONE CONGLOMERATE.
		BONNETERRE DOLOMITE	1350-2650	400	DOLOMITE; TYPICALLY A LIGHT GRAY, MEDIUM- TO FINE-GRAINED, MEDIUM-BEDDED.
		LAMOTTE SANDSTONE	1800-3100	450	PREDOMINANTLY QUARTZOSE SANDSTONE.
PRECAMBRIAN		2200-3500			IGNEOUS ROCKS.

[illegible]

FIGURE 4-1 GENERALIZED STRATIGRAPHIC COLUMN OF THE WELDON SPRING AREA

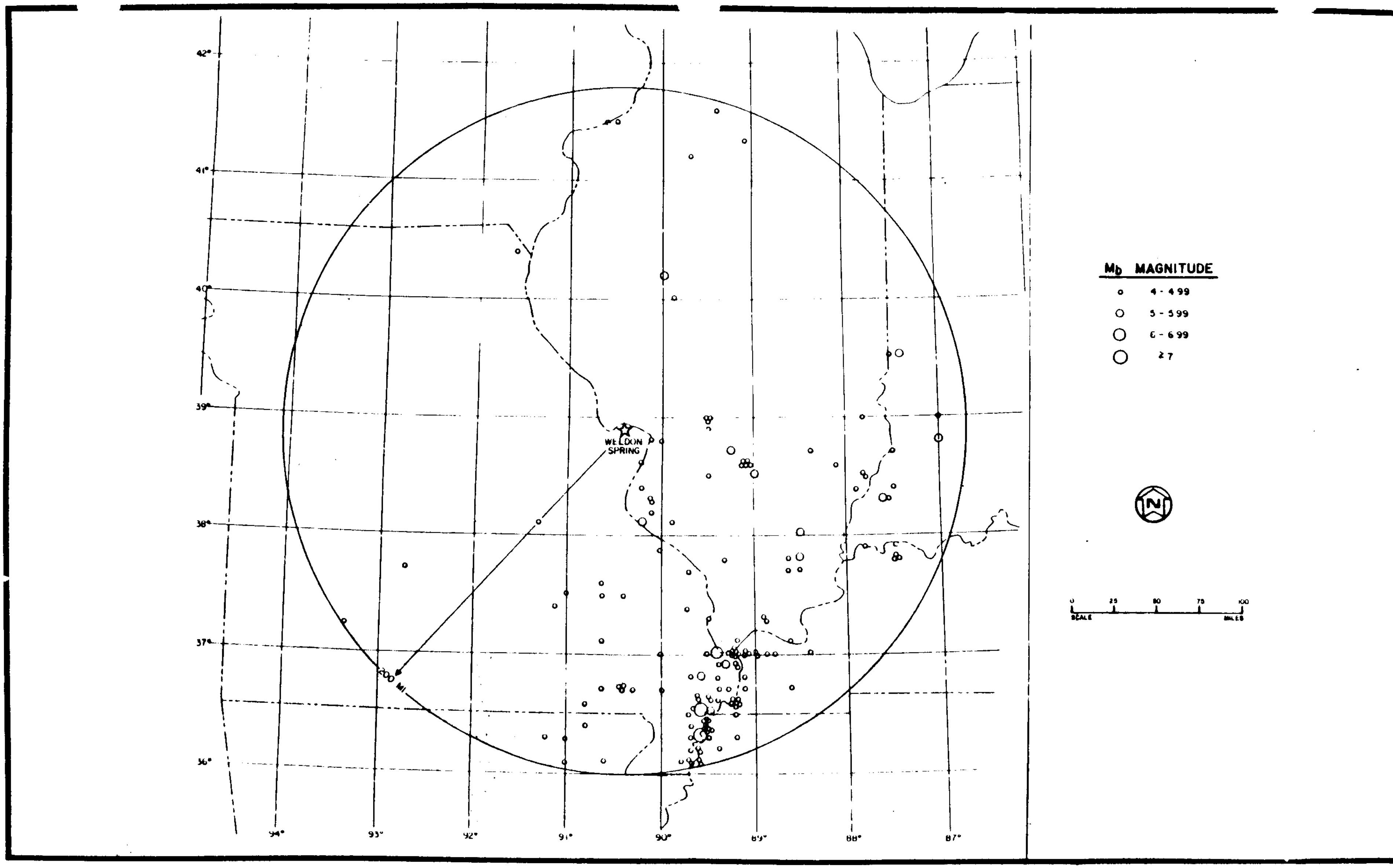


FIGURE 4-2 REGIONAL SEISMICITY WITHIN 200 MI OF THE SITE

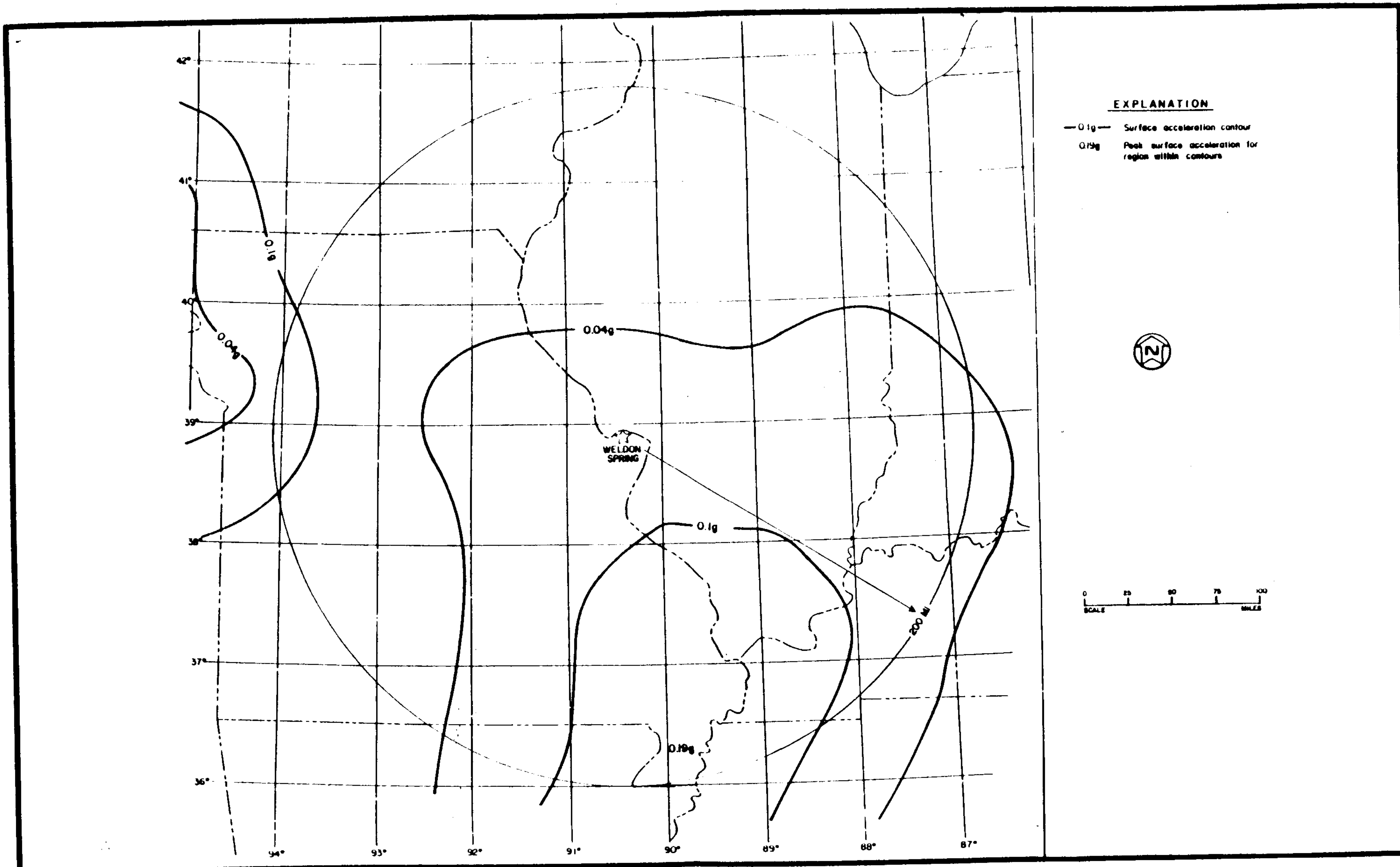


FIGURE 4-3 475-YR PEAK DYNAMIC SURFACE ACCELERATIONS

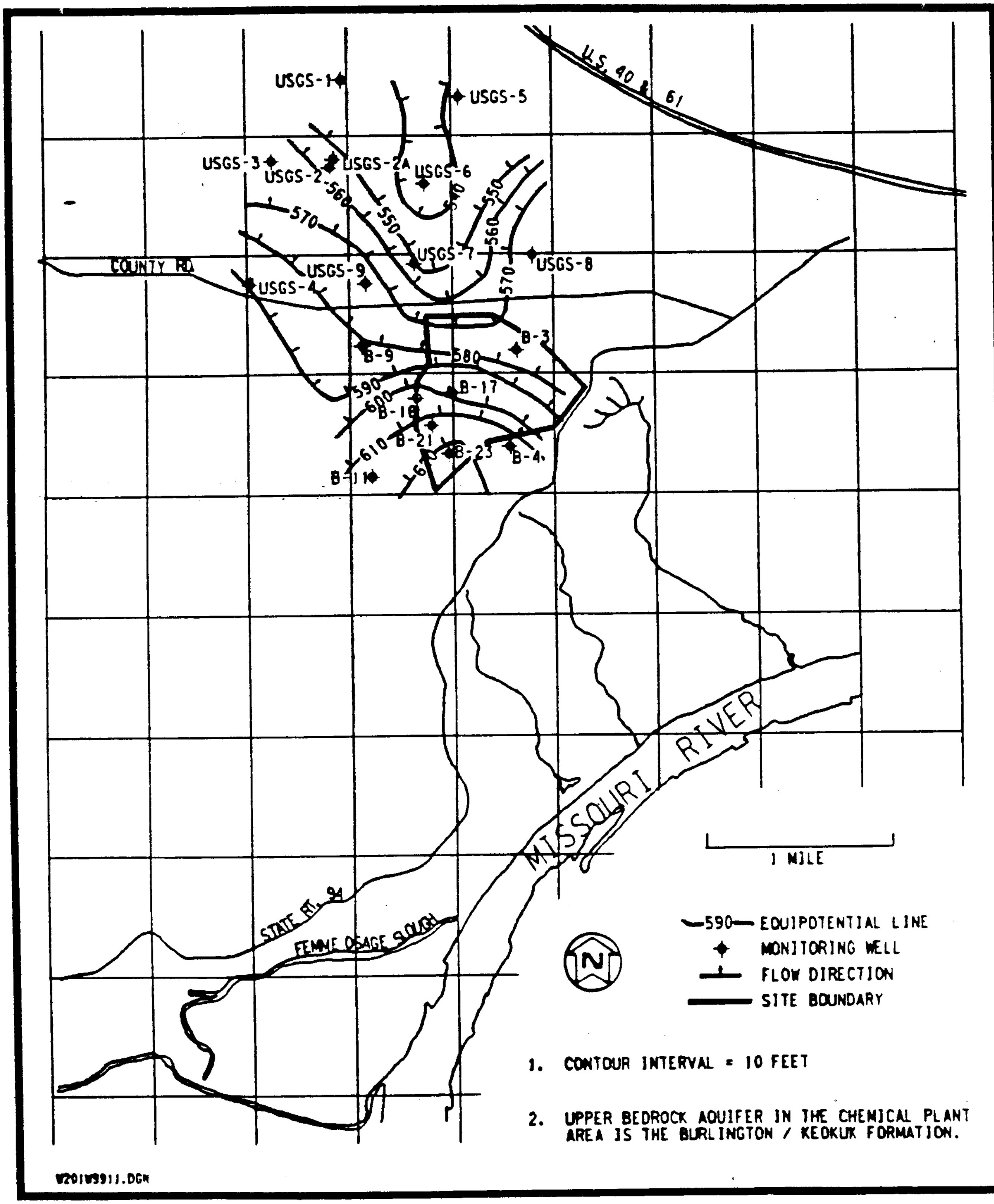
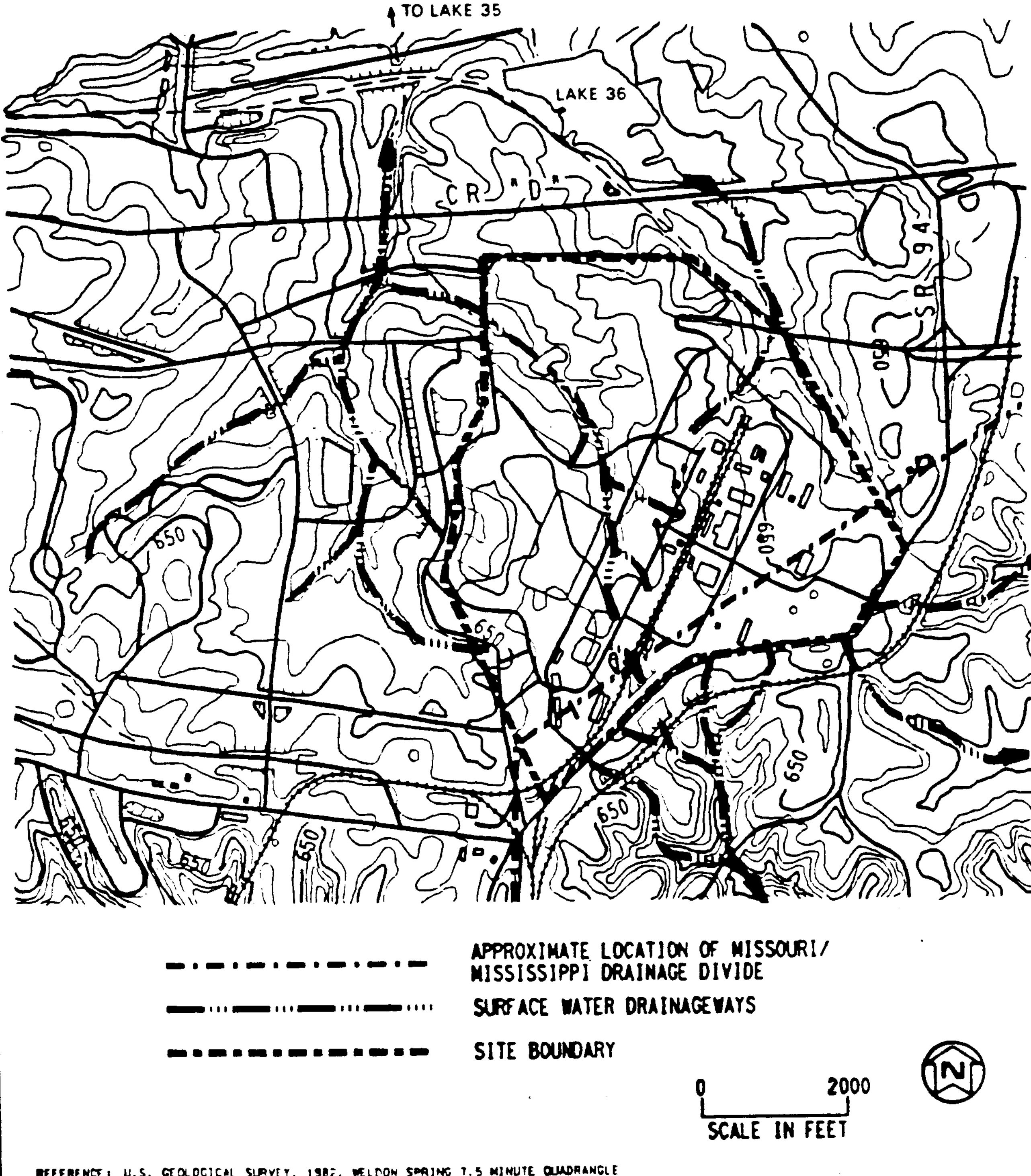


FIGURE 5-1 POTENTIOMETRIC SURFACE IN THE SHALLOW BEDROCK AQUIFER

6.0 SITE TOPOGRAPHY AND SURFACE DRAINAGE

The WSCP is located along the axis of the drainage divide between the Missouri and Mississippi River basins [Figure 6-1 (Ref. 24)]. The main plant area is essentially flat with a surface elevation of approximately 660 ft above mean sea level. Four topographic features dominate the chemical plant area. First, the man-made dikes for the raffinate pits extend up to 20 ft above the surrounding ground surface. The second and third features are the topographic depression in which the plant ash pond was constructed and the man-made dike at the northwest end of the ash pond. The fourth feature is a slope to the north along the northern margin of the chemical plant. This slope has been artificially exaggerated in the area of the steam plant to provide a level coal storage area and a depressed settling basin for the coal storage area runoff.

Surface water drainage from the site is controlled by the drainage divide mentioned previously. The southeastern portion of the chemical plant drains toward the Missouri River and the remainder of the site, including the raffinate pits and ash pond areas, drain toward the Mississippi River. Three major drainageways are present at the site. One drainageway receives runoff from the northeastern portion of the site and includes the settling basin known as the frog pond. This drainage enters Lake 36 in the Busch Wildlife Area and eventually enters the Mississippi River. A second drainageway receives runoff from the ash pond and raffinate pits area. This drainage enters Lake 35 in the Busch Wildlife Area and eventually enters the Mississippi River. The third drainageway, which was the sewage outfall for the plant, is located southeast of the plant. This drainage eventually enters the Missouri River.



REFERENCE: U.S. GEOLOGICAL SURVEY, 1982, WELDON SPRING 7.5 MINUTE QUADRANGLE TOPOGRAPHIC MAP: U.S GEOLOGICAL SURVEY

FIGURE 6-1 SITE TOPOGRAPHY AND DRAINAGE

7.0 SITE GEOLOGY

The investigation of the site geology included performing a seismic refraction survey, drilling 34 boreholes, and excavating and backfilling five trenches. The locations of the investigatory data acquisition points are shown on Figure 7-1. Summaries of information collected from the borings and trenches are presented on Tables 7-1 and 7-2, respectively. Boring logs and trench logs are presented in Appendices A and B, respectively.

Borings were advanced through the overburden using hollow stem augers and were sampled using either a split-spoon sampler or a Shelby tube sampler. Rock core samples were obtained using an NQ or NXB (3-in. diameter) wire-line coring apparatus. Trenches were excavated with a John Deere 410B backhoe and shored with hydraulic shoring prior to entry for wall mapping. All drilling and trenching activities were monitored and documented by BNI geologists. All borings not completed as groundwater monitoring wells were backfilled with cement/bentonite grout to the ground surface. Trenches were backfilled with radiologically "clean" excavation spoils, which were compacted in average lifts of 1 to 2 ft by using the backhoe bucket. The trenches were backfilled with the "clean" materials to ensure that water infiltrating through these materials would be of higher quality than water infiltrating through adjacent ground.

Results of this investigation were integrated with the results of the previous BNI investigation (Ref. 12) to interpret the site geology. The data points from the previous investigation are also shown on Figure 7-1, and a summary of boring data is included on Table 7-1.

Hydrogeological cross sections of the site were prepared using stratigraphic information from the borings. These sections are shown on Figures 7-2 through 7-4.

7.1 BEDROCK GEOLOGY

The uppermost bedrock unit underlying the site is the Burlington/Keokuk Formation. This formation is composed of fine- to coarse-grained limestone with abundant chert occurring as nodules and beds. Stratigraphic information from the borings indicates that the Burlington/Keokuk Formation can be subdivided into two units at the site. The uppermost unit is highly to moderately weathered, highly to moderately fractured, yellowish-brown to white limestone, containing 40 to 60 percent chert. This unit contains solution features ranging from vugs (up to 2 in.) to small cavities (up to 5 ft). Cavities are generally filled with silt/clay/chert gravel mixtures but may occasionally be filled with sand/chert gravel mixtures. Both solution features and predominant fractures appear to be oriented parallel to bedding in the limestone. The unit varies from 19 to 42 ft in thickness. The variability in thickness is attributed to variations in depth of weathering of the limestone. The underlying unit is a slightly weathered to fresh, slightly fractured, brownish-gray to gray limestone, containing 20 to 40 percent chert. Solution features are limited to occasional vugs in the upper portion of the unit. Stylolites (pressure solution features) and/or shale interbeds are common in this unit. In core samples, this unit appears massive and without horizontal fracturing. Core breaks generally occur along stylolites or shale interbeds. This unit is thought to represent the unweathered portion of the Burlington/Keokuk Formation.

Two seismic refraction (SR) survey lines were run (Figure 7-1) to evaluate variations in bedrock topography. SR Line 1 runs in the north-south direction east of Raffinate Pits 1 and 2; SR Line 2 runs primarily east-west and is located north of the ash pond. The results of these surveys are presented in Appendix C. The results of the surveys indicate that the top of bedrock, as defined from a borehole, could not be accurately delineated by the refraction survey. This results from an absence of significant seismic velocity contrast between the overlying residuum and glacial till and the underlying weathered bedrock. The refraction method does appear to delineate the boundary between the upper and lower units of the Burlington/Keokuk Formation. The seismic velocity of the lower unit is approximately 2 to 3 times the velocity of the upper unit.

Boring information was used to generate a bedrock topography map of the site (Figure 7-5) to allow evaluation of the preglacial paleogeomorphology of the site. The bedrock topography contour map represents an interpretation of data collected from the boreholes shown on Figure 7-1. The contours are based on a finite number of data points, and thus varying interpretations or localized variations in the bedrock surface with dimensions that do not extend to the boreholes are possible. Previous investigations (Refs. 5 and 6) indicated the presence of a large circular depression in the bedrock surface centered adjacent to the steam plant. This feature was postulated to be a paleosink. Additional subsurface information collected during this investigation indicates that this feature is more extensive than originally defined. The bedrock topography map indicates that this feature is a paleochannel. The feature appears to trend with the regional joint orientation of N30°-65°W (Ref. 2). Information from several borings (GMW-7, B-20, and B-3) indicates a gravelly zone at the base of the residuum. This zone probably represents the residue from a weathered chert zone within the bedrock.

7.2 OVERBURDEN GEOLOGY

Figure 7-6 presents an isopach map of overburden thickness. The overburden isopach map is based upon a finite amount of boring data. The interpretation presented represents the results of evaluating the boring data with respect to the geology of the area. Additional boring information would allow further refinement of these contours or may suggest an alternative configuration. This map shows that, in general, the overburden thickness follows the bedrock topography, with the thickest overburden deposits present where the bedrock is topographically the lowest.

Stratigraphic information from the borings indicates that the overburden contains six units:

- o Residuum
- o Basal till
- o Clay till
- o Ferrelview Formation
- o Loess
- o Topsoil/fill

The residuum is typically a red to yellow gravelly clay to gravelly silt. The gravel fraction is primarily composed of angular chert, with minor amounts of weathered limestone fragments. The thickness of the residuum varies from 0 to approximately 23 ft on the site. The areal distribution of the residuum varies and appears to be a function of localized weathering and erosional mechanisms.

Overlying the residuum in some areas of the site is the basal till unit. This unit is a yellowish-brown sandy, clayey silt with angular chert gravel and cobbles. Figure 7-7 presents an isopach map of this unit. The areal distribution of this unit appears to be controlled by bedrock topography, since the unit thins or is absent in areas with higher bedrock elevations and is thickest in areas of lower bedrock elevations.

Overlying the basal till is the clay till unit. The clay till is a yellowish-brown silty clay to clayey silt. This unit contains sand and gravel-size particles and pyrolusite (manganese oxide) veins and stringers. The gravel fraction is composed of subrounded to rounded granitic and mafic rocks and chert fragments. Figure 7-8 presents an isopach map of this unit.

Overlying the clay till unit in most areas of the site is the Ferrelview Formation. This unit is a dark yellowish-orange to brown color with gray mottling. The Ferrelview ranges from a silty clay to a clayey silt. Iron oxide nodules and pyrolusite veins and stringers are common in this unit. Figure 7-9 presents an isopach map of the Ferrelview Formation.

Loess deposits overlie the Ferrelview Formation, or where absent, the clay till unit. This unit is a mottled gray, dark yellowish-orange clayey silt to silty clay. The loess varies from 0 to 10.5 ft in thickness across the site. Areal distribution of the loess is quite variable due to predepositional topography and postdepositional erosion.

The topsoil/fill unit is the uppermost overburden unit at the site. The topsoil portion of the unit is a black, organically rich, silty clay or clayey silt. Topsoil thickness ranges from less than 0.5 ft to 1 ft. The fill portion of the unit is quite variable in composition. The source of the fill is thought to be primarily on-site soils which have been excavated, transported, and recompacted. The thickest areas of fill occur at the raffinate pit dikes, where up to 26 ft of fill is reported. Other minor areas of fill occur around the site, primarily for maintaining plant grade and drainage control.

7.3 OVERBURDEN CHARACTERISTICS

Disturbed (split spoon) and undisturbed (Shelby tube) samples of the major overburden units were submitted to Controls for Environmental Pollution (CEP) of Santa Fe, New Mexico, for soil testing. Results of the soil tests are summarized on Table 7-3, and test data sheets are presented in Appendix D. The data presented on Table 7-3 are broken down by individual units to examine variability within units and provide a comparison between units.

Comparison of grain size distributions of the four units indicates that the basal till has the highest gravel content, the clay till has the highest sand and clay content, and the loess has the highest silt content. The Ferrelview Formation contains a higher percentage of silt than the clay till does, yet the Ferrelview is thought to be derived from the clay till. The higher silt content of the Ferrelview may reflect loess deposited contemporaneously with the Ferrelview.

The two most critical parameters measured in the soil testing program were effective cation exchange capacity and distribution ratio. The clay till unit exhibited the highest cation exchange, followed by the Ferrelview Formation and finally the basal till. The loess unit was not examined in this study due to its limited areal extent on the site. The results of these tests are as could be expected from the percentages of clay in each unit. The clay till has the highest clay content and thus has the highest surface area and largest number of surface charged particles available for exchange reactions to occur. The basal till has the least amount of clay and contains significant amounts of quartz and amorphous silica (chert) which provide less possibility for sorption reactions to occur. Distribution ratios were measured using a 10.44 mg/l uranium source solution. The results of the distribution ratio tests indicate the opposite results from the cation exchange capacity tests, with the basal till having the highest distribution ratio and the clay till having the lowest distribution ratio. Visual examination of the samples by laboratory personnel indicates that the basal till sample has the highest organic content of the samples tested. This suggests that the reactions observed in the basal till sample may involve complex formation and/or oxidation-reduction reactions created by the reducing conditions surrounding the organic matter, rather than by sorptive processes. The cation exchange capacity measurements show the basal till as having the lowest cation exchange capacity which indicates a low sorptive capacity of the soil. The implication of this reasoning is that the ability of the basal till to immobilize radionuclides is directly tied to organic content and the geochemical environment and may vary both spatially and temporally.

Seeley and Kelmers (Ref. 25) determined distribution ratios for uranium (VI) and radium-226 of five soil samples taken of raffinate pit dike fill and natural soil. Distribution ratios for uranium (VI) were determined using source concentrations of 5 mg/l and 10,000 mg/l. Distribution ratios for the 5 mg/l-source concentration ranged from 12 to 1,300 ml/g and for the 10,000 mg/l, they ranged from 0.72 to 1.6 ml/g. Distribution ratios for radium-226 were determined using a source concentration of 100,000 pCi/ml and ranged from 660 to 18,000 ml/g.

In addition to the parameters measured by the laboratory, other relevant soil parameters were calculated for the Ferrelview Formation, the clay till unit, and the basal till unit. These parameters are also shown on Table 7-3. These data indicate that the Ferrelview Formation has the highest saturation, specific retention, and activity, and the lowest specific yield (Ref. 26). This is further supported by the work performed by Howe and Heim (Ref. 17) on the Ferrelview Formation. They state that construction experience with the Ferrelview has indicated that it has a very high capacity for moisture retention and that it tends to dry out very slowly.

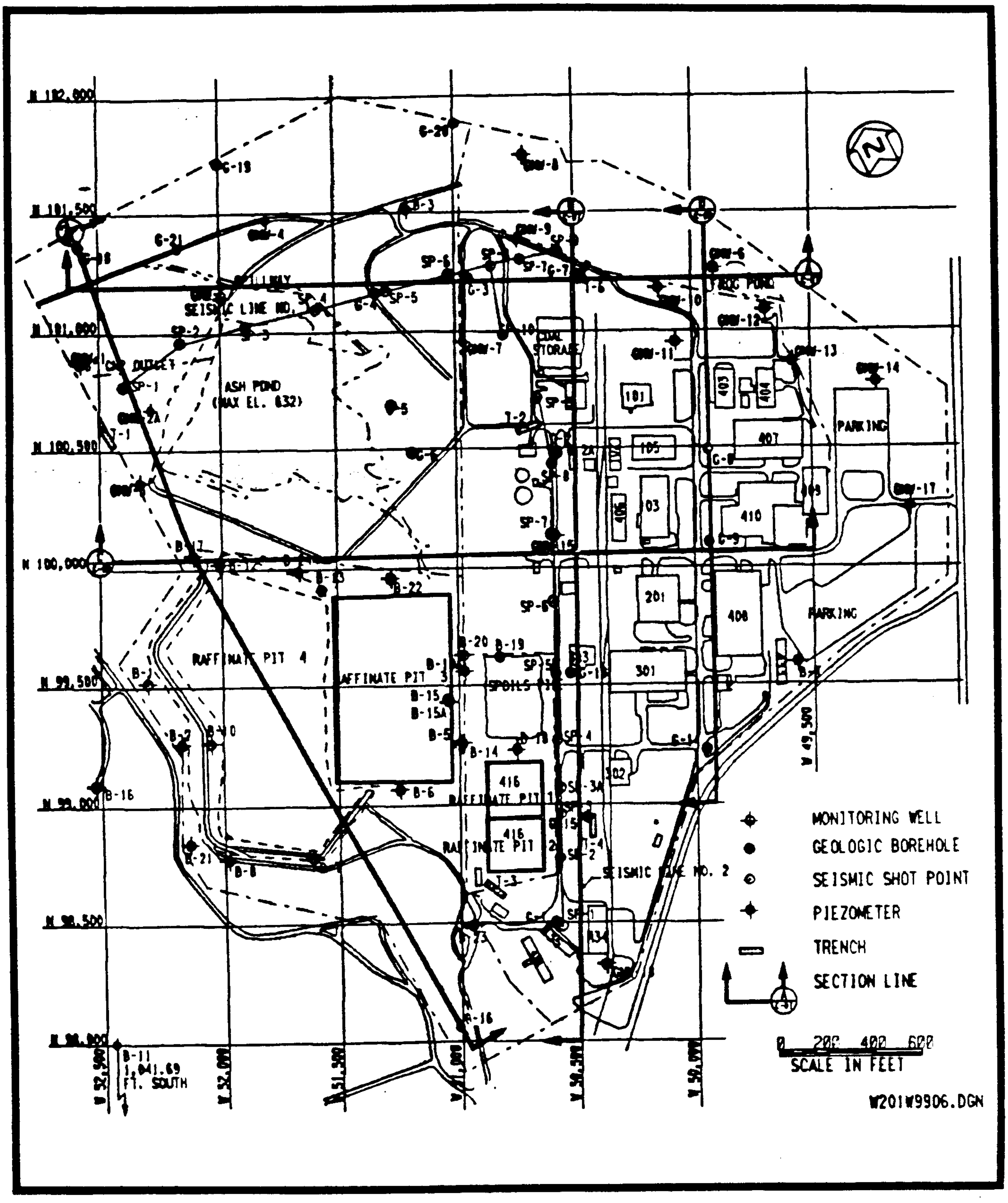


FIGURE 7-1 EXPLORATION LOCATION PLAN

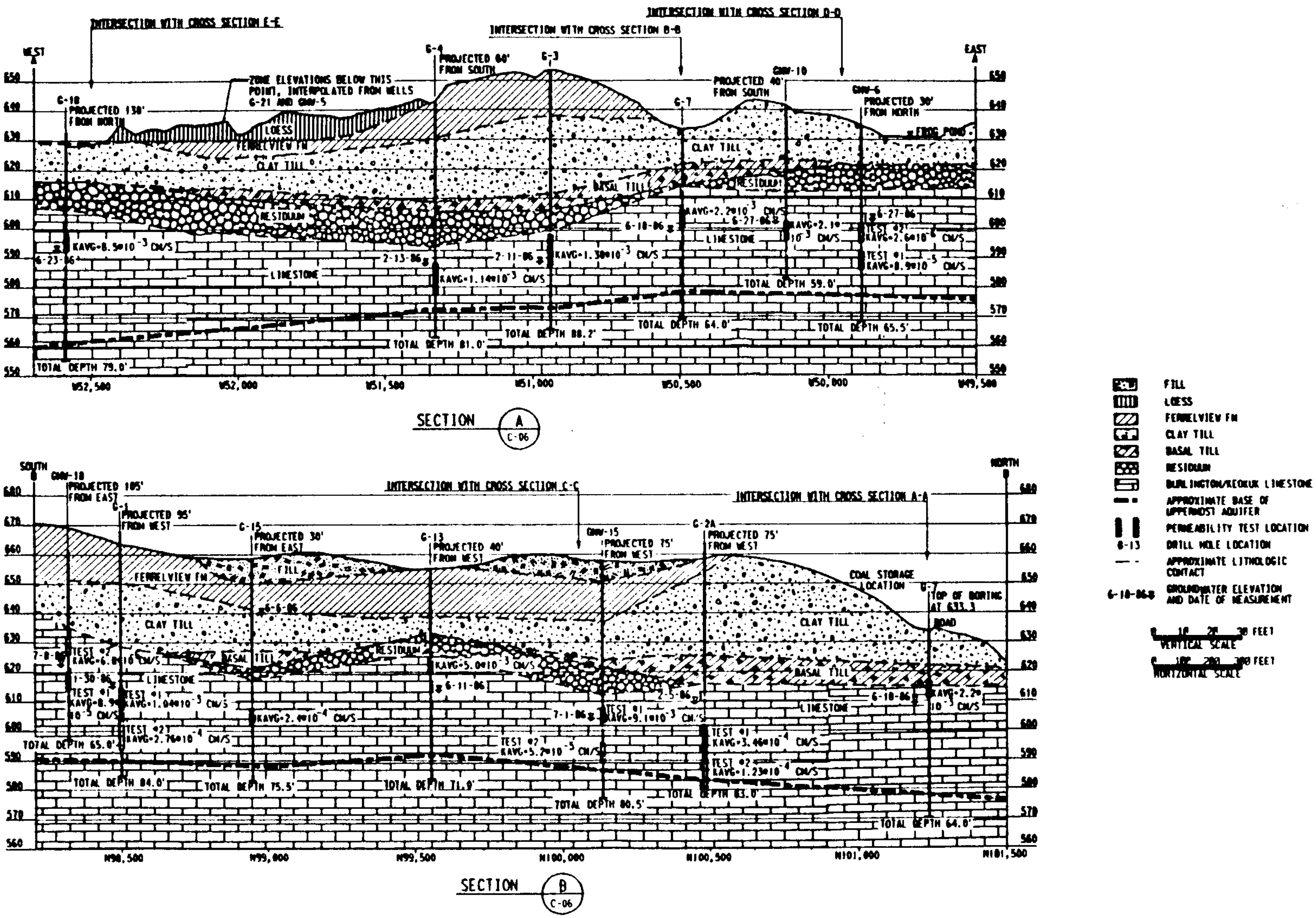


FIGURE 7-2 GEOLOGIC CROSS SECTIONS A-A AND B-B

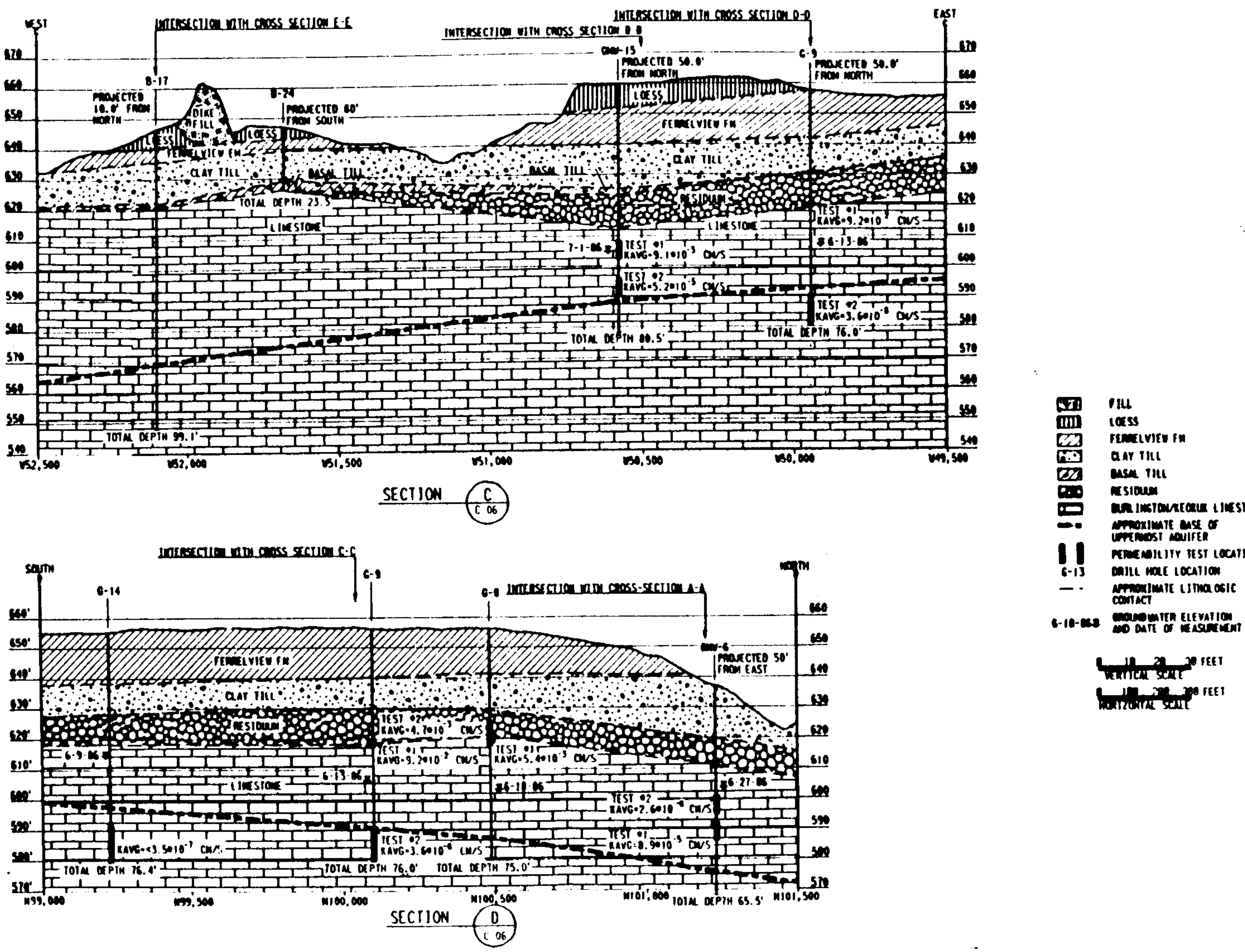
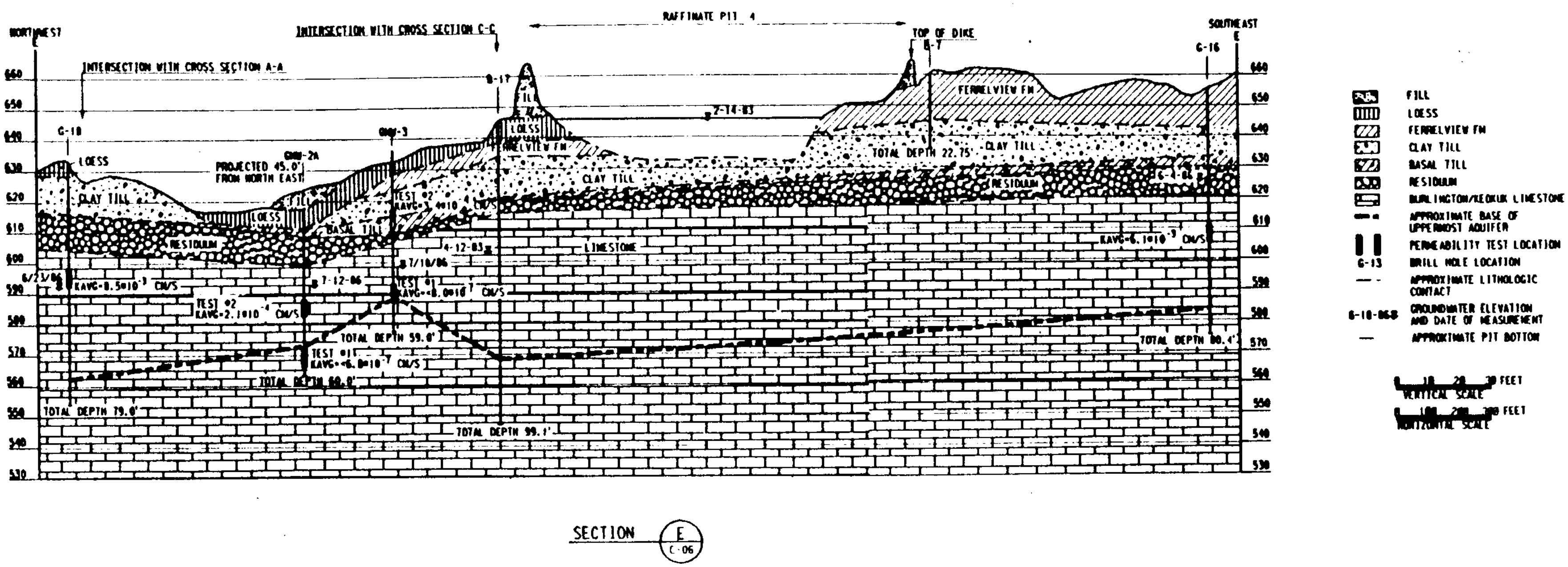


FIGURE 7-3 GEOLOGIC CROSS SECTIONS C-C AND D-D



W201W9909.DGN

FIGURE 7-4 GEOLOGIC CROSS SECTION E-E

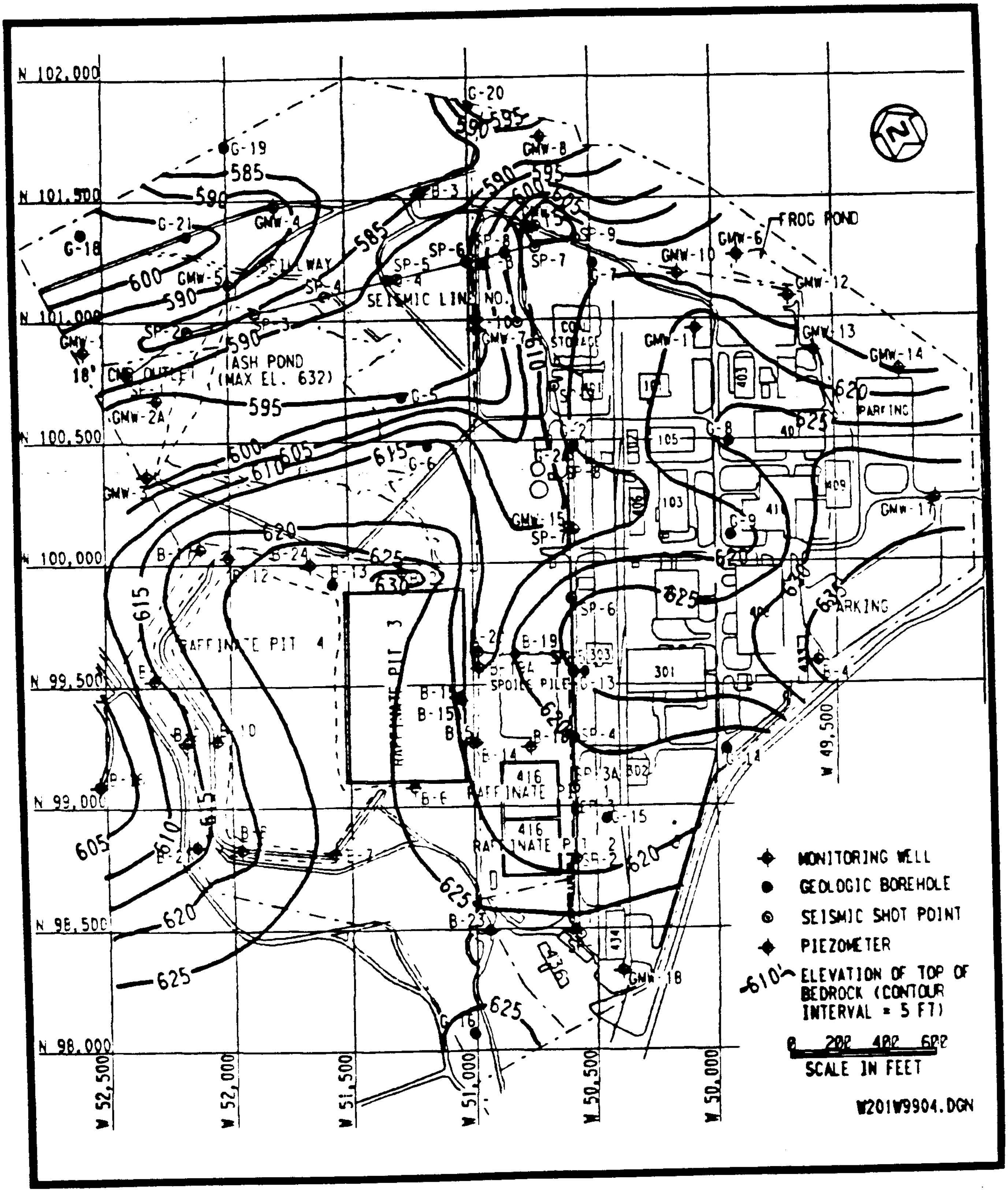


FIGURE 7-5 BEDROCK TOPOGRAPHY MAP

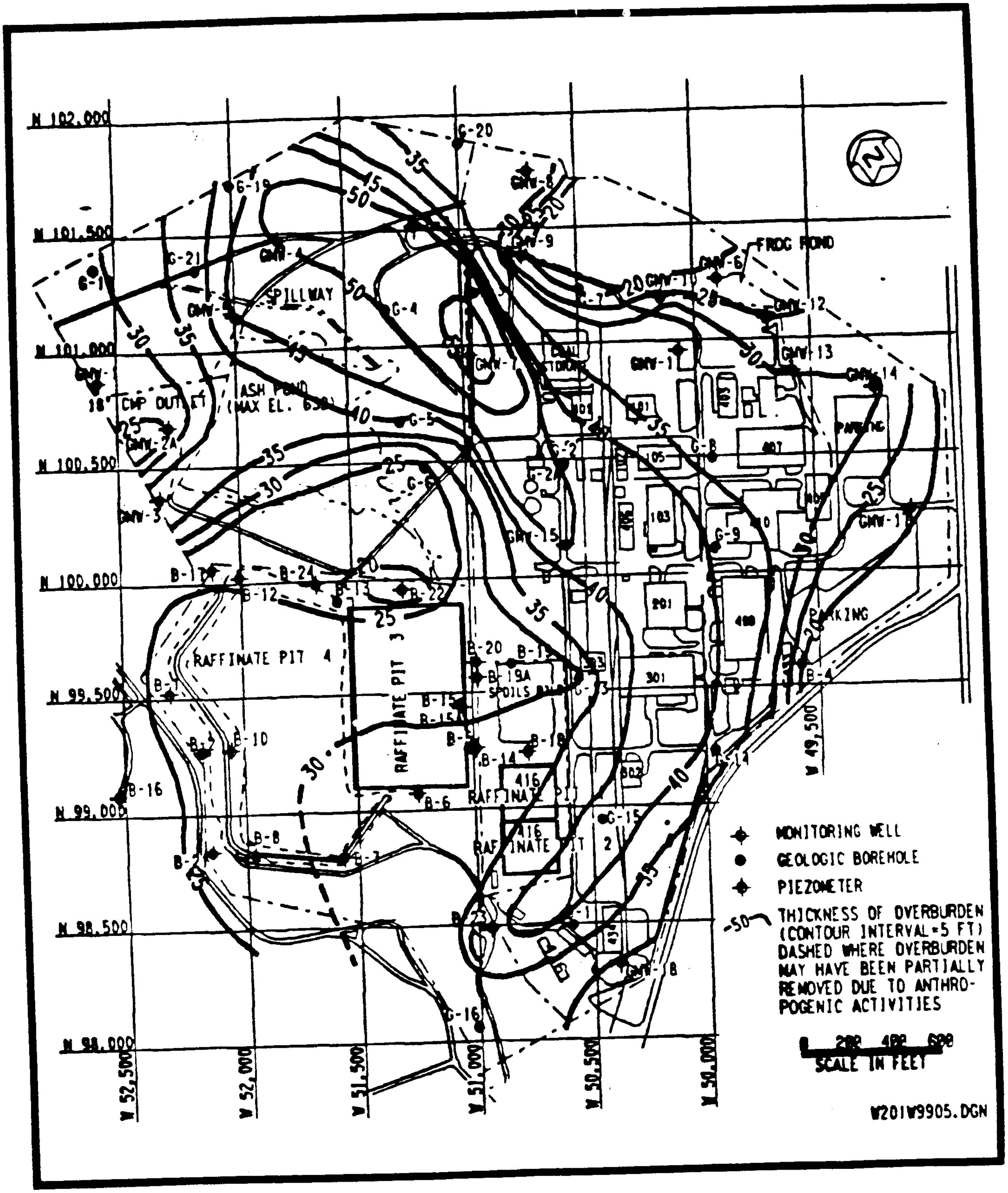


FIGURE 7-6 ISOPACH OF OVERBURDEN

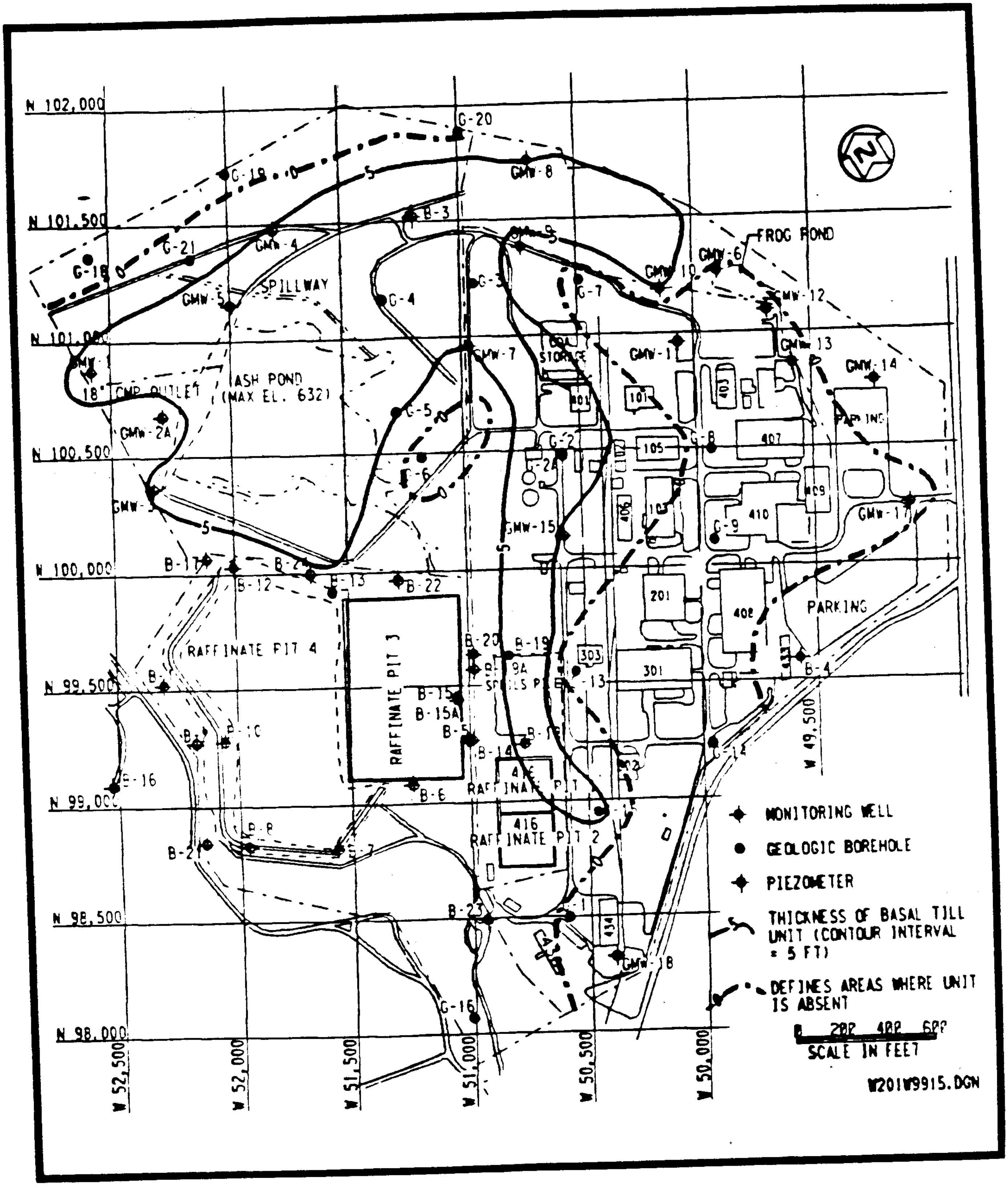


FIGURE 7-7 ISOPACH OF BASAL TILL UNIT

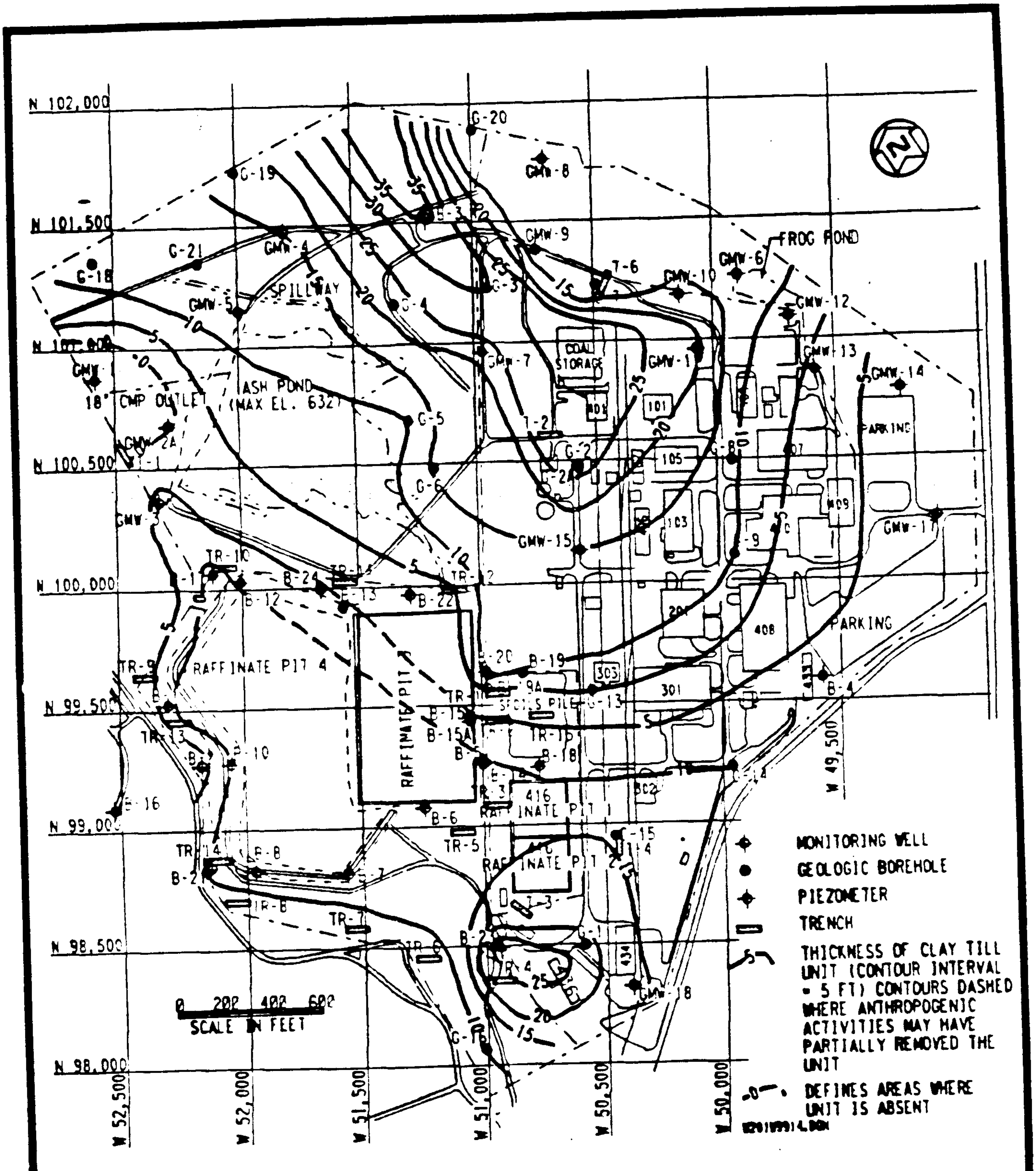


FIGURE 7-8 ISOPACH OF CLAY TILL UNIT

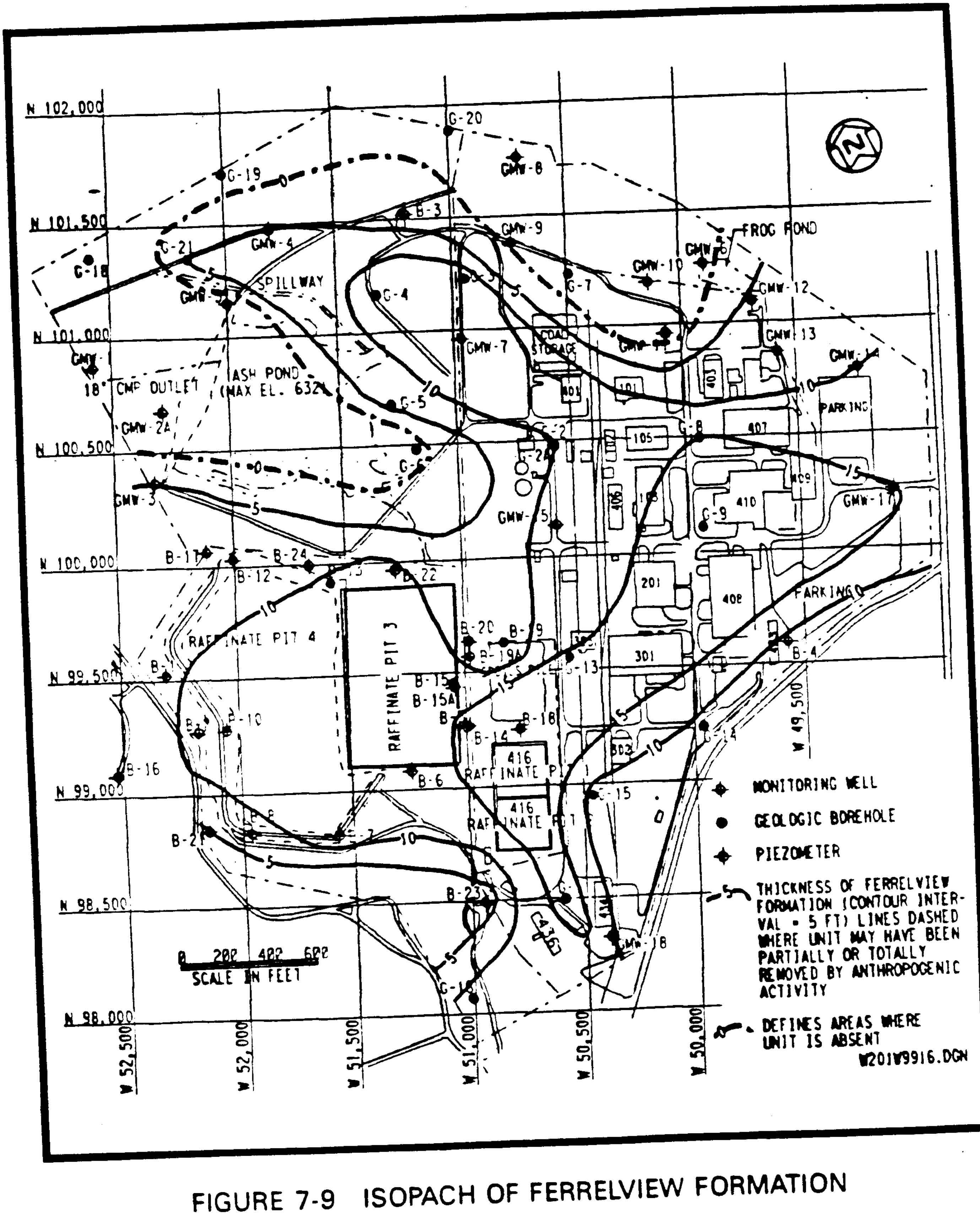


FIGURE 7-9 ISOPACH OF FERRELVIEW FORMATION

TABLE 7-1

BORING SUMMARY

Borehole Number[a]	North Coordinate[b]	West Coordinate[b]	Ground Elevation[c]	Overburden Thickness (ft)[d]	Residuum Thickness (ft)[d]	Depth to Top of Sound Rock (ft)[d]	Total Depth of Hole (ft)	Depth to Groundwater (ft)	Installation Date
B-1	99507.31	52283.25	638.89	-	-	-	21.5	Dry	02/16/83
B-2	99255.75	52139.58	631.04	29.6	-	-	29.6	22.6	02/21/83
B-3	101532.61	51176.70	635.10	54.0	4.0	54.0	150.5	56.5	03/11/83
B-4	99548.26	49549.08	655.19	18.0	5.7	23.7	119.6	38.9	03/16/83
B-5	99235.26	50975.59	653.29	-	-	-	21.5	8.01	03/22/83
B-6	99050.01	51224.33	663.72	-	-	-	21.5	20.5	03/17/83
B-7	98764.40	51596.95	658.17	-	-	-	22.75	Dry	03/23/83
B-8	98750.81	51969.06	646.68	27.0	-	-	33.0	Dry	03/23/83
B-9	99848.34	54284.63	632.72	21.0	0	21.0	84.7	50.7	04/04/83
B-10	99257.79	52044.62	665.85	-	-	-	25.6	Dry	03/24/83
B-11	96958.31	52458.57	669.86	23.0	6.0	23.0	106.2	63.5	03/29/83
B-12	100003.42	51968.88	663.60	-	-	-	30.0	Dry	03/25/83
B-13	99890.22	51545.69	663.78	-	-	-	27.0	Dry	03/28/83
B-14	99236.90	50965.65	653.53	-	-	-	21.83	22.1	04/08/83
B-15	99420.65	51025.38	663.94	-	-	-	30.0	19.0	04/11/83
B-15A	99410.29	51021.62	663.42	-	-	-	37.0	Dry	04/11/83
B-16	99084.02	52513.02	621.67	27.0	8.0	-	28.5	17.4	04/18/83
B-17	100043.37	52082.13	645.64	29.0	3.93	29.0	99.1	42.0	04/12/83
B-18	99218.80	50750.75	658.75	-	-	-	24.0	Dry	04/11/83
B-19	99596.66	50805.60	645.37	21.0	-	-	21.5	Dry	04/08/83
B-19A	99546.41	50954.29	645.17	28.0	8.0	30.0	101.0	35.0	04/25/83
B-20	99597.59	50956.60	643.75	29.5	8.49	29.5	29.5	Dry	04/08/83
B-21	98832.52	52123.23	644.41	35.0	12.0	35.0	99.4	35.7	04/19/83
B-22	9931.65	51266.71	647.36	15.0	-	-	15.0	9.33	04/15/83
B-23	98471.52	50936.42	665.09	38.0	0	38.0	90.7	52.0	04/19/83
B-24	99969.05	51635.20	649.22	23.5	-	-	23.5	22.35	04/15/83
G-1	98473	50581	668.0	39.7	0	45.3	84.0	53.23	01/30/86
G-2A	100440	50578	658.0	42.5	2.3	44.8	83.0	53.20	02/05/86
G-3	101195	50949	654.0	54.6	7.0	54.6	88.2	65.55	02/11/86
G-4	101141	51296	644.0	50.0	12.5	53.0	81.0	56.10	02/13/86
G-5	100650	51250	635.9	40.0	18.0	40.0	73.0	38.00	08/04/86
G-6	100450	51150	639.7	23.5	7.5	23.5	67.0	10.71	06/20/86

TABLE 7-1

(continued)

Borehole Number[a]	North Coordinate[b]	West Coordinate[b]	Ground Elevation[c]	Overburden Thickness (ft)[d]	Residuum Thickness (ft)[d]	Depth to Top of Sound Rock (ft)[d]	Total Depth of Hole (ft)	Depth to Groundwater (ft)	Installation Date
G-7	101200	50450	633.3	18.5	7.0	18.5	64.0	34.20	06/18/86
G-8	100450	49900	655.3	30.0	4.0	34.3	75.0	52.12	06/18/86
G-9	100065	49905	656.0	37.5	11.5	37.5	76.0	49.47	06/16/86
G-13	99521	50517	654.7	28.5	6.5	28.5	71.0	31.08	06/12/86
G-14	99199	49935	655.8	37.5	10.0	37.5	76.4	41.40	06/09/86
G-15	98924	50447	658.0	41.0	4.0	41.0	75.5	18.10	06/06/86
G-16	98051	51007	656.7	34.0	9.0	34.0	80.4	30.10	06/05/86
G-18	101350	52551	633.8	29.0	11.5	36.0	79.0	41.00	06/23/86
G-19	101700	51950	619.4	41.5	22.7	41.5	66.0	40.50	06/24/86
G-20	101850	50950	630.3	32.5	16.0	32.5	66.0	44.30	06/23/86
G-21	101336	52116	638.7	34.2	7.2	54.0	74.5	52.00	07/31/86
GMW-1	100858	52554	612.1	26.5	11.8	26.5	60.0	23.30	07/14/86
GMW-2A	100658	52253	624.0	24.5	9.5	29.0	60.0	31.0	07/12/86
GMW-3	100347	52299	636.8	38.8	10.8	38.8	59.0	38.10	07/10/86
GMW-4	101450	51750	642.8	51.0	18.0	51.0	72.0	51.40	07/24/86
GMW-5	101131	51950	635.7	44.8	12.1	44.8	76.0	47.41	07/23/86
GMW-6	101223	49852	633.8	22.6	8.6	22.6	65.5	30.10	06/27/86
GMW-7	100928	50933	649.0	59.0	13.0	59.0	94.0	48.80	07/09/86
GMW-8	101720	50659	619.9	31.5	14.5	31.5	57.0	34.20	06/25/86
GMW-9	101350	50700	636.7	20.5	5.5	26.5	54.0	39.00	06/26/86
GMW-10	101150	50100	642.1	29.5	6.0	32.8	59.0	40.00	06/27/86
GMW-11	100916	50030	653.0	32.0	5.0	32.0	74.0	52.00	06/30/86
GMW-12	101050	49643	636.2	25.5	5.5	25.5	60.0	40.00	07/02/86
GMW-13	100819	49539	645.5	27.5	6.5	27.5	70.0	39.60	07/03/86
GMW-14	100735	49186	647.3	33.0	12.0	35.0	59.0	43.00	07/07/86
GMW-15	100100	50550	657.4	45.5	9.0	45.5	80.5	53.41	08/01/86
GMW-17	100200	49050	657.8	23.5	0	23.5	64.0	52.30	06/25/86
GMW-18	98297	50382	661.4	32.5	5.5	32.5	65.0	39.40	07/08/86

[a]Boreholes B-1 through B-24 were surveyed in 1983; boreholes G-1 through GMW-18 were surveyed in 1986.
[b]Coordinates are based on the AEC coordinate system.
[c]Elevations are based on the USGS system.
[d]Zero indicates that the unit is absent; dash indicates that the borehole did not extend to or through the particular unit.

TABLE 7-2

TRENCH SUMMARY

Trench Number	Center Point Coordinates[a]		Total Depth (ft)	Average Unit Thickness (ft)				
	N	W		Topsoil/ Fill	Clayey Silt (Loess)	Ferrelview Formation	Glacial Till	Residuum
T-1	100,546.5	52,437.5	15.0	0.8	4.2	-	-	10.0
T-2	100,555.5	50,662.0	15.0	0.6	2.2	6.8	5.4	-
T-3	98,621.0	50,844.0	15.0	1.5	6.4	7.1	-	-
T-4	98,886.5	50,427.0	15.0	5.5	-	9.5	-	-
T-6	101,206.5	50,411.0	16.0	2.4	-	1.3	11.3	-

[a]Coordinates are based on the AEC coordinate system.

TABLE 7-3

SOIL TESTING SUMMARY

Borehole Number	Sample Number	Depth Interval (ft)	Percentages of Grain Sizes			
			Gravel	Sand	Silt	Clay
LOESS UNIT						
G-18	1	3.5 - 5.0	0	6	65	29
G-21	SS-1	3.5 - 5.0	-	-	-	-
GMW-1	SS-1	3.5 - 5.0	-	-	-	-
GMW-3	SS-1	5.5 - 7.0	0	5	65	30
GMW-4	SS-1	3.5 - 5.0	-	-	-	-
GMW-5	SS-1	3.5 - 5.0	0	5	67	28
GMW-7	SS-1	3.5 - 5.0	-	-	-	-
GMW-11	SS-1	3.5 - 5.0	0	3	64	33
GMW-15	SS-1	3.5 - 5.0	0	3	59	38
mean			0	4.4	64	31.6
standard deviation			± 0	± 1.3	± 3	± 4
n			5	5	5	5

TABLE 7-3

(continued)

Borehole Number	Sample Number	Depth Interval (ft)	Liquid Limit	Plasticity Index	Unified Soil Classification
LOESS UNIT					
G-18	1	3.5 - 5.0	-	-	-
G-21	SS-1	3.5 - 5.0	-	-	-
GMW-1	SS-1	3.5 - 5.0	30	13	CL
GMW-3	SS-1	5.5 - 7.0	-	-	-
GMW-4	SS-1	3.5 - 5.0	-	-	-
GMW-5	SS-1	3.5 - 5.0	-	-	-
GMW-7	SS-1	3.5 - 5.0	-	-	-
GMW-11	SS-1	3.5 - 5.0	-	-	-
GMW-15	SS-1	3.5 - 5.0	-	-	-
mean			-	-	-
standard deviation			-	-	-
n			1	1	1

TABLE 7-3

(continued)

Borehole Number	Sample Number	Depth Interval (ft)	Specific Gravity (g/cm^3)	Unit Weight Dry (lb/ft^3)	Unit Weight Wet (lb/ft^3)
LOESS UNIT					
G-18	1	3.5 - 5.0	-	-	-
G-21	SS-1	3.5 - 5.0	2.58	-	-
GMW-1	SS-1	3.5 - 5.0	-	-	-
GMW-3	SS-1	5.5 - 7.0	-	92.3	110.6
GMW-4	SS-1	3.5 - 5.0	-	85.5	101.7
GMW-5	SS-1	3.5 - 5.0	-	95.2	106.9
GMW-7	SS-1	3.5 - 5.0	-	101.6	122.7
GMW-11	SS-1	3.5 - 5.0	-	101.9	125.1
GMW-15	SS-1	3.5 - 5.0	-	86.6	92.8
mean			-	93.8	110.0
standard deviation			-	±7.1	±12.4
n			1	6	6

TABLE 7-3
(continued)

Borehole Number	Sample Number	Depth Interval (ft)	Moisture Content	Centrifuge Moisture Equivalent	Effective Cation Exchange Capacity (meq/100g)	Distribution Ratio (ml/g)
LOESS UNIT						
G-18	1	3.5 - 5.0	-	-	-	-
G-21	SS-1	3.5 - 5.0	-	-	-	-
GMW-1	SS-1	3.5 - 5.0	-	-	-	-
GMW-3	SS-1	5.5 - 7.0	-	-	-	-
GMW-4	SS-1	3.5 - 5.0	-	-	-	-
GMW-5	SS-1	3.5 - 5.0	-	-	-	-
GMW-7	SS-1	3.5 - 5.0	-	-	-	-
GMW-11	SS-1	3.5 - 5.0	-	-	-	-
GMW-15	SS-1	3.5 - 5.0	-	-	-	-
mean			-	-	-	-
standard deviation			-	-	-	-
n			0	0	0	0

TABLE 7-3

(continued)

Borehole Number	Sample Number	Depth Interval (ft)	CALCULATED PARAMETERS: Void Ratio[a]	Porosity[b]	Specific Retention[c]	Specific Yield[d]	Saturation[e]	Activity[f]
LOESS UNIT								
G-18	1	3.5 - 5.0	-	-	-	-	-	-
G-21	SS-1	3.5 - 5.0	-	-	-	-	-	-
GMW-1	SS-1	3.5 - 5.0	-	-	-	-	-	-
GMW-3	SS-1	5.5 - 7.0	-	-	-	-	-	-
GMW-4	SS-1	3.5 - 5.0	-	-	-	-	-	-
GMW-5	SS-1	3.5 - 5.0	-	-	-	-	-	-
GMW-7	SS-1	3.5 - 5.0	-	-	-	-	-	-
GMW-11	SS-1	3.5 - 5.0	-	-	-	-	-	-
GMW-15	SS-1	3.5 - 5.0	-	-	-	-	-	-
mean			-	-	-	-	-	-
standard deviation			-	-	-	-	-	-
n			0	0	0	0	0	0

TABLE 7-3

(continued)

Borehole Number	Sample Number	Depth Interval (ft)	Percentages of Grain Sizes: Gravel	Sand	Silt	Clay
FERRELVIEW FORMATION						
G-8	1	3.5 - 5.0	5	14	47	39
G-8	3	11.5 - 13.5	0	4	47	49
G-9	2	6.5 - 8.5	0	3	56	41
G-14	1	3.5 - 5.0	-	-	-	-
G-16	1	3.5 - 5.0	-	-	-	-
G-21	SS-2	8.5 - 10.0	-	-	-	-
GMW-3	SS-2	8.5 - 10.0	0	16	26	58
GMW-3	ST-1	11.5 - 13.5	0	14	41	45
GMW-7	ST-1	11.5 - 13.5	0	12	42	46
GMW-12	ST-1	10.0 - 11.5	10	14	63	13
GMW-13	ST-1	11.5 - 13.5	0	7	48	45
GMW-15	ST-1	11.5 - 13.5	<19	3	53	44
GMW-17/ G-10	SS-2	8.5 - 10.0	-	-	-	-
GMW-18	SS-1	3.5 - 5.0	9	17	49	34
GMW-18	SS-2	8.5 - 10.0	-	-	-	-
mean			2.8	9.8	49.6	39.6
standard deviation			±4.1	±5.5	±6.9	±10.9
n			10	10	10	10

TABLE 7-3

(continued)

Borehole Number	Sample Number	Depth Interval (ft)	Liquid Limit	Plasticity Index	Unified Soil Classification
FERRELVIEW FORMATION					
G-8	1	3.5 - 5.0	-	-	-
G-8	3	11.5 - 13.5	49	33	CL
G-9	2	6.5 - 8.5	40	23	CL
G-14	1	3.5 - 5.0	-	-	-
G-16	1	3.5 - 5.0	-	-	-
G-21	SS-2	8.5 - 10.0	63	43	CH
GMW-3	SS-2	8.5 - 10.0	-	-	-
GMW-3	ST-1	11.5 - 13.5	55	41	CH
GMW-7	ST-1	11.5 - 13.5	55	37	CH
GMW-12	ST-1	10.0 - 11.5	50	32	CL-CH
GMW-13	ST-1	11.5 - 13.5	45	28	CL
GMW-15	ST-1	11.5 - 13.5	61	44	CH
GMW-17/ G-10	SS-2	8.5 - 10.0	-	-	-
GMW-18	SS-1	3.5 - 5.0	-	-	-
GMW-18	SS-2	8.5 - 10.0	-	-	-
mean			52.2	35.1	CL-CH
standard deviation			± 7.8	± 7.5	-
n			8	8	8

TABLE 7-3

(continued)

Borehole Number	Sample Number	Depth Interval (ft)	Specific Gravity (g/cm^3)	Unit Weight Dry (lb/ft^3)	Unit Weight Wet (lb/ft^3)
FERRELVIEW FORMATION					
G-8	1	3.5 - 5.0	-	-	-
G-8	3	11.5 - 13.5	2.53	115.1	127.3
G-9	2	6.5 - 8.5	2.63	103.5	124.0
G-14	1	3.5 - 5.0	2.45	-	-
G-16	1	3.5 - 5.0	2.62	-	-
G-21	SS-2	8.5 - 10.0	-	-	-
GMW-3	SS-2	8.5 - 10.0	2.56	-	-
GMW-3	ST-1	11.5 - 13.5	2.62	101.7	126.8
GMW-7	ST-1	11.5 - 13.5	2.64	108.0	129.0
GMW-12	ST-1	10.0 - 11.5	2.59	73.3	99.9
GMW-13	ST-1	11.5 - 13.5	2.66	101.9	121.4
GMW-15	ST-1	11.5 - 13.5	2.67	98.8	123.4
GMW-17/ G-10	SS-2	8.5 - 10.0	-	107.9	126.5
GMW-18	SS-1	3.5 - 5.0	-	-	-
GMW-18	SS-2	8.5 - 10.0	2.67	-	-
mean			2.61	101.3	122.3
standard deviation			±0.07	±12.4	±9.4
n			11	8	8

TABLE 7-3

(continued)

Borehole Number	Sample Number	Depth Interval (ft)	Moisture Content	Centrifuge Moisture Equivalent	Effective Cation Exchange Capacity (meq/100g)	Distribution Ratio (ml/g)
FERRELVIEW FORMATION						
G-8	1	3.5 - 5.0	-	-	-	-
G-8	3	11.5 - 13.5	24.5	41	-	-
G-9	2	6.5 - 8.5	24.6	35	-	-
G-14	1	3.5 - 5.0	-	-	-	-
G-16	1	3.5 - 5.0	-	-	-	-
G-21	SS-2	8.5 - 10.0	-	-	-	-
GMW-3	SS-2	8.5 - 10.0	-	-	-	-
GMW-3	ST-1	11.5 - 13.5	24.7	47	-	-
GMW-7	ST-1	11.5 - 13.5	24.6	46	-	-
GMW-12	ST-1	10.0 - 11.5	25.7	-	60.2	47.9
GMW-13	ST-1	11.5 - 13.5	23.8	-	60.4	61.6
GMW-15	ST-1	11.5 - 13.5	24.9	58	-	-
GMW-17/ G-10	SS-2	8.5 - 10.0	-	-	-	-
GMW-18	SS-1	3.5 - 5.0	-	-	-	-
GMW-18	SS-2	8.5 - 10.0	-	-	-	-
mean			24.7	45.4	60.3	54.8
standard deviation			±0.6	±8.5	±0.1	±9.7
n			7	5	2	2

TABLE 7-3

(continued)

Borehole Number	Sample Number	Depth Interval (ft)	CALCULATED PARAMETERS: Void Ratio[a]	Porosity[b]	Specific Retention[c]	Specific Yield[d]	Saturation[e]	Activity[f]
FERRELVIEW FORMATION								
G-8	1	3.5 - 5.0	-	-	-	-	-	-
G-8	3	11.5 - 13.5	0.37	27%	33%	0%	100%	0.67
G-9	2	6.5 - 8.5	0.58	37%	28%	9%	100%	0.56
G-14	1	3.5 - 5.0	-	-	-	-	-	-
G-16	1	3.5 - 5.0	-	-	-	-	-	-
G-21	SS-2	8.5 - 10.0	-	-	-	-	-	-
GMW-3	SS-2	8.5 - 10.0	-	-	-	-	-	-
GMW-3	ST-1	11.5 - 13.5	0.29	22%	38%	0%	100%	0.91
GMW-7	ST-1	11.5 - 13.5	0.52	34%	37%	0%	100%	0.80
GMW-12	ST-1	10.0 - 11.5	0.62	38%	-	-	100%	2.46
GMW-13	ST-1	11.5 - 13.5	0.63	39%	-	-	100%	0.62
GMW-15	ST	11.5 - 13.5	0.69	41%	46%	0%	96.4%	1.00
GMW-17/ G-10	SS-2	8.5 - 10.0	-	-	-	-	-	-
GMW-18	SS-1	3.5 - 5.0	-	-	-	-	-	-
GMW-18	SS-2	8.5 - 10.0	-	-	-	-	-	-
mean			0.53	34%	36%	2%	100%	1.00
standard deviation			±0.15	±7	±7	±4	±1.4	±0.66
n			7	7	5	5	7	7

TABLE 7-3

(continued)

Borehole Number	Sample Number	Depth Interval (ft)	Percentages of Grain Sizes			
			Gravel	Sand	Silt	Clay
CLAY TILL UNIT						
G-5	ST-1	6.5 - 8.5	<19	20	31	49
G-5	SS-3	13.5 - 15.0	0	31	27	42
G-6	1	3.5 - 5.0	-	-	-	-
G-6	3	11.5 - 13.5	1	22	32	45
G-8	6	21.5 - 23.5	0	22	32	46
G-9	5	16.5 - 18.5	0	21	30	49
G-19	2	6.5 - 8.5	<19	27	29	44
G-20	2	6.0 - 8.0	0	14	36	50
G-21	ST-1	16.5 - 18.5	0	27	31	42
GMW-3	SS-4	18.5 - 20.0	-	-	-	-
GMW-4	ST-1	11.5 - 13.5	0	22	34	44
GMW-4	SS-4	18.5 - 20.0	0	28	31	41
GMW-5	ST-1	11.5 - 13.5	0	26	31	43
GMW-6	ST-1	11.5 - 13.5	0	18	28	54
GMW-7	SS-6	28.5 - 30.0	0	25	34	41
GMW-8	ST-1	11.5 - 12.5	4	22	35	39
GMW-10	ST-1	11.5 - 13.5	0	25	35	40
GMW-11	ST-1	13.5 - 15.5	0	18	31	51
GMW-13	SS-4	18.5 - 20.0	-	-	-	-
GMW-14	ST-1	11.5 - 12.5	0	16	32	52
GMW-15	SS-6	28.5 - 30.0	-	-	-	-
GMW-17/ G-10	SS-4	18.5 - 20.0	-	-	-	-
GMW-18	ST-1	11.5 - 13.5	0	20	32	48
mean			0.4	22.4	31.7	45.6
standard deviation			±1.0	±4.5	±2.4	±4.5
n			18	18	18	18

TABLE 7-3

(continued)

Borehole Number	Sample Number	Depth Interval (ft)	Liquid Limit	Plasticity Index	Unified Soil Classification
CLAY TILL UNIT					
G-5	ST-1	6.5 - 8.5	53	36	CH
G-5	SS-3	13.5 - 15.0	-	-	-
G-6	1	13.5 - 5.0	-	-	-
G-6	3	11.5 - 13.5	46	29	CL
G-8	6	21.5 - 23.5	47	31	CL
G-9	5	16.5 - 18.5	50	34	CL-CH
G-19	2	6.5 - 8.5	41	27	CL
G-20	2	6.0 - 8.0	62	43	CH
G-21	ST-1	16.5 - 18.5	42	29	CL
GMW-3	SS-4	18.5 - 20.0	81	56	CH
GMW-4	ST-1	11.5 - 13.5	48	33	CL
GMW-4	SS-4	18.5 - 20.0	-	-	-
GMW-5	ST-1	11.5 - 13.5	44	29	CL
GMW-6	ST-1	11.5 - 13.5	42	28	CL
GMW-7	SS-6	28.5 - 30.0	-	-	-
GMW-8	ST-1	11.5 - 12.5	44	28	CL
GMW-10	ST-1	11.5 - 13.5	39	23	CL
GMW-11	ST-1	13.5 - 15.5	58	44	CH
GMW-13	SS-4	18.5 - 20.0	-	-	-
GMW-14	ST-1	11.5 - 12.5	53	39	CH
GMW-15	SS-6	28.5 - 30.0	-	-	-
GMW-17/ G-10	SS-4	18.5 - 20.0	-	-	-
GMW-18	ST-1	11.5 - 13.5	55	39	CH
mean			50.3	34.2	CL
standard deviation			±10.5	±8.4	-
n			16	16	16

TABLE 7-3

(continued)

Borehole Number	Sample Number	Depth Interval (ft)	Specific Gravity (g/cm^3)	Unit Weight Dry (lb/ft^3)	Unit Weight Wet (lb/ft^3)
CLAY TILL UNIT					
G-5	ST-1	6.5 - 8.5	2.43	105.4	129.5
G-5	SS-3	13.5 - 15.0	-	-	-
G-6	1	3.5 - 5.0	2.67	-	-
G-6	3	11.5 - 13.5	2.65	110.6	136.6
G-8	6	21.5 - 23.5	2.61	103.9	121.1
G-9	5	16.5 - 18.5	2.60	107.3	127.6
G-19	2	6.5 - 8.5	2.68	107.9	125.9
G-20	2	6.0 - 8.0	2.67	96.7	121.4
G-21	ST-1	16.5 - 18.5	2.64	-	-
GMW-3	SS-4	18.5 - 20.0	-	-	-
GMW-4	ST-1	11.5 - 13.5	2.46	102.9	122.7
GMW-4	SS-4	18.5 - 20.0	-	-	-
GMW-5	ST-1	11.5 - 13.5	2.62	113.4	132.6
GMW-6	ST-1	11.5 - 13.5	2.66	104.7	121.7
GMW-7	SS-6	28.5 - 30.0	-	-	-
GMW-8	ST-1	11.5 - 12.5	2.37	100.3	113.3
GMW-10	ST-1	11.5 - 13.5	-	104.6	117.7
GMW-11	ST-1	13.5 - 15.5	2.55	105.5	129.7
GMW-13	SS-4	18.5 - 20.0	2.68	-	-
GMW-14	ST-1	11.5 - 12.5	2.68	98.2	121.5
GMW-15	SS-6	28.5 - 30.0	2.68	-	-
GMW-17/ G-10	SS-4	18.5 - 20.0	2.62	-	-
GMW-18	ST-1	11.5 - 13.5	2.55	105.2	112.2
mean			2.60	104.8	123.8
standard deviation			±0.09	±4.4	±7.0
n			18	14	14

TABLE 7-3

(continued)

Borehole Number	Sample Number	Depth Interval (ft)	Moisture Content	Centrifuge Moisture Equivalent	Effective Cation Exchange Capacity (meq/100g)	Distribution Ratio (ml/g)
CLAY TILL UNIT						
G-5	ST-1	6.5 - 8.5	22.9	34	-	-
G-5	SS-3	13.5 - 15.0	-	-	-	-
G-6	1	3.5 - 5.0	-	-	-	-
G-6	3	11.5 - 13.5	18.0	36	-	-
G-8	6	21.5 - 23.5	16.9	33	-	-
G-9	5	16.5 - 18.5	18.7	45	-	-
G-19	2	6.5 - 8.5	16.9	37	-	-
G-20	2	6.0 - 8.0	23.5	46	-	-
G-21	ST-1	16.5 - 18.5	14.2	-	60.8	38.6
GMW-3	SS-4	18.5 - 20.0	-	-	-	-
GMW-4	ST-1	11.5 - 13.5	19.7	41	-	-
GMW-4	SS-4	18.5 - 20.0	-	-	-	-
GMW-5	ST-1	11.5 - 13.5	18.7	34	-	-
GMW-6	ST-1	11.5 - 13.5	18.6	34	-	-
GMW-7	SS-6	28.5 - 30.0	-	-	-	-
GMW-8	ST-1	11.5 - 12.5	15.7	51	-	-
GMW-10	ST-1	11.5 - 13.5	17.2	40	-	-
GMW-11	ST-1	13.5 - 15.5	23.3	41	-	-
GMW-13	SS-4	18.5 - 20.0	-	-	-	-
GMW-14	ST-1	11.5 - 12.5	23.3	45	-	-
GMW-15	SS-6	28.5 - 30.0	-	-	-	-
GMW-17/ G-10	SS-4	18.5 - 20.0	-	-	-	-
GMW-18	ST-1	11.5 - 13.5	21.7	-	77.3	29.9
mean			19.3	39.7	69.0	34.2
standard deviation			±3.0	±5.7	±11.7	±6.2
n			15	13	2	2

TABLE 7-3

(continued)

Borehole Number	Sample Number	Depth Interval (ft)	Void Ratio[a]	Porosity[b]	Specific Retention[c]	Specific Yield[d]	Saturation[e]	Activity[f]
			CALCULATED PARAMETERS					
CLAY TILL UNIT								
G-5	ST-1	6.5 - 8.5	0.44	30%	27%	3%	100%	0.73
G-5	SS-3	13.5 - 15.0	-	-	-	-	-	-
G-6	1	3.5 - 5.0	-	-	-	-	-	-
G-6	3	11.5 - 13.5	0.50	33%	29%	4%	95.4%	0.64
G-8	6	21.5 - 23.5	0.57	36%	26%	10%	77%	0.67
G-9	5	16.5 - 18.5	0.51	34%	36%	0%	95.3%	0.69
G-19	2	6.5 - 8.5	0.55	35%	30%	5%	82.3%	0.61
G-20	2	6.0 - 8.0	0.72	42%	37%	5%	87.1%	0.86
G-21	ST-1	16.5 - 18.5	-	-	-	-	-	0.69
GMW-3	SS-4	18.5 - 20.0	-	-	-	-	-	-
GMW-4	ST-1	11.5 - 13.5	0.49	33%	32.8%	0.2%	98.9%	0.75
GMW-4	SS-4	18.5 - 20.0	-	-	-	-	-	-
GMW-5	ST-1	11.5 - 13.5	0.44	30%	27%	3%	100%	0.67
GMW-6	ST-1	11.5 - 13.5	0.58	37%	27%	10%	85.3%	0.52
GMW-7	SS-6	28.5 - 30.0	-	-	-	-	-	-
GMW-8	ST-1	11.5 - 12.5	0.47	32%	41%	0%	79.1%	0.72
GMW-10	ST-1	11.5 - 13.5	-	-	32%	-	-	0.58
GMW-11	ST-1	13.5 - 15.5	0.51	34%	33%	1%	100%	0.86
GMW-13	SS-4	18.5 - 20.0	-	-	-	-	-	-
GMW-14	ST-1	11.5 - 12.5	0.70	41%	36%	5%	89.2%	0.75
GMW-15	SS-6	28.5 - 30.0	-	-	-	-	-	-
GMW-17/ G-10	SS-4	18.5 - 20.0	-	-	-	-	-	-
GMW-18	ST-1	11.5 - 13.5	0.51	34%	-	-	100%	0.81
mean			0.54	35%	32%	4%	91.5%	0.70
standard deviation			±0.09	±3.6	±4.7	±3.5	± 8.6	±0.10
n			13	13	13	12	13	15

TABLE 7-3

(continued)

Borehole Number	Sample Number	Depth Interval (ft)	Percentages of Grain Sizes			
			Gravel	Sand	Silt	Clay
BASAL TILL UNIT						
G-15	7	33.5 - 35.0	0	8	56	36
G-21	SS-5	23.5 - 24.2	0	6	63	31
GMW-1	ST-1	11.5 - 13.5	39	26	10	25
GMW-2	ST-1	11.5 - 12.5	25	41	16	18
GMW-5	SS-5	23.5 - 25.0	-	-	-	-
GMW-7	SS-9	43.5 - 45.0	0	6	59	35
GMW-9	ST-1	11.5 - 13.5	0	25	35	40
mean			10.7	18.7	39.8	30.8
standard deviation			±17.1	±14.3	±23.0	±8.1
n			6	6	6	6

TABLE 7-3

(continued)

Borehole Number	Sample Number	Depth Interval (ft)	Liquid Limit	Plasticity Index	Unified Soil Classification
BASAL TILL UNIT					
G-15	7	33.5 - 35.0	-	-	-
G-21	SS-5	23.5 - 24.2	35	19	CL
GMW-1	ST-1	11.5 - 13.5	66	43	GC
GMW-2	ST-1	11.5 - 12.5	35	16	SC
GMW-5	SS-5	23.5 - 25.0	31	14	GC
GMW-7	SS-9	43.5 - 45.0	-	-	-
GMW-9	ST-1	11.5 - 13.5	41	26	CL
mean			41.6	23.6	GC-CL
standard deviation			±14.1	±11.7	-
n			5	5	5

TABLE 7-3
(continued)

Borehole Number	Sample Number	Depth Interval (ft)	Specific Gravity (g/cm^3)	Unit Weight Dry (lb/ft^3)	Unit Weight Wet (lb/ft^3)
BASAL TILL UNIT					
G-15	7	33.5 - 35.0	-	104.8	126.5
G-21	SS-5	23.5 - 24.2	-	99.4	114.1
GMW-1	ST-1	11.5 - 13.5	2.45	86.5	107.9
GMW-2	ST-1	11.5 - 12.5	-	-	-
GMW-5	SS-5	23.5 - 25.0	-	-	-
GMW-7	SS-9	43.5 - 45.0	-	103.6	126.8
GMW-9	ST-1	11.5 - 13.5	-	104.8	117.9
mean			-	99.8	118.6
standard deviation			-	±7.8	±8.1
n			1	5	5

TABLE 7-3

(continued)

Borehole Number	Sample Number	Depth Interval (ft)	Moisture Content	Centrifuge Moisture Equivalent	Effective Cation Exchange Capacity (meq/100g)	Distribution Ratio (ml/g)
BASAL TILL UNIT						
G-15	7	33.5 - 35.0	-	-	-	-
G-21	SS-5	23.5 - 24.2	-	-	-	-
GMW-1	ST-1	11.5 - 13.5	23.0	40	-	-
GMW-2	ST-1	11.5 - 12.5	23.1	-	29.0	206
GMW-5	SS-5	23.5 - 25.0	-	-	-	-
GMW-7	SS-9	43.5 - 45.0	-	-	-	-
GMW-9	ST-1	11.5 - 13.5	16.5	37	-	-
mean			20.9	38.5	-	-
standard deviation			±3.8	±2.1	-	-
n			3	2	1	1

TABLE 7-3

(continued)

Borehole Number	Sample Number	Depth Interval (ft)	CALCULATED PARAMETERS					
			Void Ratio[a]	Porosity[b]	Specific Retention[c]	Specific Yield[d]	Saturation[e]	Activity[f]
BASAL TILL UNIT								
G-15	7	33.5 - 35.0	-	-	-	-	-	-
G-21	SS-5	23.5 - 24.2	-	-	-	-	-	0.61
GMW-1	ST-1	11.5 - 13.5	0.77	44%	32%	8%	73.2%	1.72
GMW-2	ST-1	11.5 - 12.5	-	-	-	-	-	0.89
GMW-5	SS-5	23.5 - 25.0	-	-	-	-	-	-
GMW-7	SS-9	43.5 - 45.0	-	-	-	-	-	-
GMW-9	ST-1	11.5 - 13.5	-	-	30%	-	-	0.65
mean			-	-	31%	-	-	0.97
standard deviation			-	-	±1	-	-	±0.52
n			1	1	2	1	1	4

TABLE 7-3

(continued)

Borehole Number	Sample Number	Depth Interval (ft)	Percentages of Grain Sizes: Gravel	Sand	Silt	Clay
FILL						
GMW-8	SS-1	3.5 - 5.0	20	48	19	13

TABLE 7-3
(continued)

Borehole Number	Sample Number	Depth Interval (ft)	Liquid Limit	Plasticity Index	Unified Soil Classification
FILL					
GMW-8	SS-1	3.5 - 5.0	-	-	SM

TABLE 7-3

(continued)

Borehole Number	Sample Number	Depth Interval (ft)	Specific Gravity (g/cm^3)	Unit Weight Dry (lb/ft^3)	Unit Weight Wet (lb/ft^3)
FILL					
GMW-8	SS-1	3.5 - 5.0	2.54	-	-

TABLE 7-3

(continued)

Borehole Number	Sample Number	Depth Interval (ft)	Moisture Content	Centrifuge Moisture Equivalent	Effective Cation Exchange Capacity (meq/100g)	Distribution Ratio (ml/g)
FILL						
GMW-8	SS-1	3.5 - 5.0	-	-	-	-

TABLE 7-3

(continued)

Borehole Number	Sample Number	Depth Interval (ft)	CALCULATED PARAMETERS					
			Void Ratio[a]	Porosity[b]	Specific Retention[c]	Specific Yield[d]	Saturation[e]	Activity[f]
FILL								
GMW-8	SS-1	3.5 - 5.0	-	-	-	-	-	-

NOTES:

[a]Void Ratio = (specific gravity x unit weight of water/dry unit weight) - 1

[b]Porosity = (void ratio/1 + void ratio) x 100%

[c]Specific Retention = centrifuge moisture equivalent x 0.80 (Ref. 26)

[d]Specific Yield = porosity - specific retention

[e]Saturation = (specific gravity x moisture content)/void ratio

[f]Activity = plasticity index/percent of clay

[g]1 percent used for mean and standard deviation determinations

8.0 SITE HYDROGEOLOGY

The site hydrogeological investigation included delineation of the uppermost aquifer, installation of groundwater monitoring wells, determination of groundwater movement including direction, gradient, and velocity, and evaluation of site hydrogeochemistry.

8.1 AQUIFERS

The uppermost aquifer at the site is the upper fractured and weathered zone in the Burlington/Keokuk Formation. A saturated zone in the residuum unit was also noted in boreholes G-19 and GMW-15, but since this zone appeared to be localized in these areas, the residuum was not considered in the hydrogeological investigation of the site.

To characterize the permeability of the uppermost aquifer, borehole field permeability tests were performed during the drilling program. These tests included constant head (packer) tests as described by the U.S. Bureau of Reclamation (Ref. 27) and variable head tests as described by Hvorslev (Ref. 28). Packer testing equipment was calibration tested to develop a head loss curve for the equipment, with supplemental head loss curves taken from the U.S. Bureau of Reclamation (Ref. 29). Results of the field permeability tests are presented on Table 8-1. Test results are also presented on the hydrogeological cross sections (Figures 7-2 through 7-4) to allow evaluation of lateral and vertical variations in permeability. Permeability tests were conducted in four specific zones as shown on the table. The upper two zones represent the vadose zone in the bedrock, the third zone is the uppermost aquifer, and the fourth zone represents the unweathered bedrock underlying the aquifer. Permeability testing at the overburden/bedrock interface was limited due to difficulties in maintaining a seal around the outside of the hollow stem augers. Permeability tests were attempted in this zone in all but the first four boreholes (G-1 through G-4) drilled during this investigation. Leakage of water around the outside of the augers occurred in all tests except for those presented in Table 8-1. Tests in both the unsaturated and saturated zones in the bedrock indicate variations in permeability of up to four orders of magnitude. These variations in permeability may-result from variations in the interconnection of solution features and/or variations in solution feature filling materials or degree of filling. Comparison of permeability measurements in the weathered and unweathered portions of the bedrock indicate that average permeabilities in the fresh rock section are three orders of magnitude lower than in the weathered bedrock. The results of the permeability testing program indicate that the aquifer is of variable permeability in the horizontal plane and generally becomes less permeable with depth due to decreased weathering and associated solution activity.

8.2 MONITORING WELL INSTALLATIONS

Assessment of the site hydrogeological conditions requires groundwater monitoring wells to allow acquisition of groundwater level and groundwater quality data.

An electromagnetic terrain conductivity (EM) survey was performed prior to finalizing groundwater monitoring well locations. The EM survey data can be used to detect changes in conductivity in the subsurface, such as would be created by a conductive plume of contaminated groundwater. The results of the EM survey are presented in Appendix E. The EM survey data indicated that an anomalous high conductivity area was present in the eastern portion of the site. A groundwater monitoring well (GMW-17) was relocated from its original design location to investigate this anomaly.

A system of 17 groundwater monitoring wells was designed to monitor groundwater quality. The wells were designed with type 316L schedule 40 stainless steel casing and screen for durability and chemical stability. The wells are designated with a GMW prefix to differentiate them from previously installed wells of polyvinylchloride construction. As-built well construction details are presented in Appendix F, and locations are shown on Figure 7-1. Table 8-2 presents a summary of the monitoring well installation data, including those wells installed during the previous BNI (Ref. 12) investigation.

Boreholes were reamed to 8-1/2-in. diameter using an air rotary tricone roller bit drilling system prior to well installation. All drilling equipment, casing, and screens were steam cleaned prior to each well installation to preclude downhole contamination or cross-contamination between boreholes. Water used for well installation and development activities was obtained from the St. Charles County water supply system. Following well installation, all monitoring wells were developed by air lift pumping and flushing with water to remove the maximum practical amount of fine-grained materials from the well.

8.3 GROUNDWATER MOVEMENT

Investigation of groundwater movement involved measurement of groundwater levels in the uppermost aquifer. Table 8-3 presents the results of two groundwater level measurement surveys. These two surveys were taken to represent two seasons of the hydrological year. The measurements taken at the end of July represent the low recharge season when precipitation is minimal and evapotranspiration is maximal in an average year. The measurements taken in November represent an increased recharge period due to a reduction in evapotranspiration (Ref. 30). These measurement sets were contoured to generate the potentiometric surface maps shown on Figures 8-1 and 8-2. These maps represent an interpretation of spatially and temporally limited data. Additional monitoring points and groundwater level measurements will allow further refinement of the potentiometric contours.

8.3.1 Groundwater Flow Direction

Examination of the potentiometric surface maps (Figures 8-1 and 8-2) indicates that a groundwater divide passes through the eastern portion of the site, beneath the surface water divide (Section 6.0). Groundwater to the east of this divide flows east-southeast toward the Missouri River. Groundwater to the west of the divide flows north-northwest toward the Mississippi River.

8.3.2 Hydraulic Gradient

Hydraulic gradients can be qualitatively evaluated by examination of the spacing of the equipotential lines on the potentiometric surface maps. Closely spaced equipotential lines indicate a steep hydraulic gradient, and widely spaced lines indicate a shallow hydraulic gradient. Variations in spacing of equipotential lines within an aquifer may indicate a change in aquifer permeability. This phenomenon relates to Darcy's Law which states that groundwater flow is equal to the permeability times the hydraulic gradient times the cross sectional area of flow. To maintain steady-state flow, when the permeability decreases, the hydraulic gradient must increase, since the cross sectional area is assumed to be a constant. This phenomenon can be observed on the two potentiometric surface maps, in the area of GMW-6 (frog pond area). Permeability values (Table 8-1) for GMW-6, GMW-8, and GMW-13 are two to three orders of magnitude below the average permeability for the aquifer.

Quantitative measurements of hydraulic gradients in the central and western portions of the site range from 0.02 to 0.03. The hydraulic gradient in the area of GMW-6 is approximately 0.05.

8.3.3 Groundwater Velocity

The average interstitial velocity of groundwater can be approximated by a modified form of Darcy's Law (Ref. 31):

$$V = \frac{Ki}{\alpha}$$

where

V = groundwater velocity (L/T)

K = permeability (L/T)

i = hydraulic gradient (dimensionless)

α = porosity

Using the average aquifer permeability 1.6×10^{-3} cm/s (4.5 ft/day), a hydraulic gradient of 0.025, and an average porosity for limestone of 0.30 (Ref. 31), the resulting average interstitial velocity is 0.4 ft/day. In the area of GMW-6, using a permeability of 8.9×10^{-5} cm/s (0.25 ft/day), a hydraulic gradient of 0.05, and an average porosity for limestone of 0.30 (Ref. 31), the average interstitial velocity is 0.04 ft/day. It should be noted that the groundwater gradients and velocities discussed herein assume conditions of Darcian flow. The fractured nature of the aquifer indicates, at least locally, that the constraints for Darcian flow are not met and conduit flow is occurring. The intent of the discussion of hydraulic gradients and interstitial velocities is to provide preliminary macroscale characteristics of the aquifer. To fully evaluate the effects of the non-Darcian flow would require utilization of tracer studies and other techniques to characterize localized groundwater flow.

8.4 HYDROGEOCHEMISTRY

A total of 27 groundwater and raffinate pit water samples were taken in September and October of 1986. Thirteen of these samples were submitted for chemical and radiological analyses. An additional 10 samples were scheduled for chemical analyses but, due to a DOE stop work order, could not be submitted for analysis prior to expiration of the storage period for the analytical parameters. Four additional samples were submitted only for radiological analysis. Chemical analyses were performed by Envirodyne Engineers of St. Louis, Missouri, and radiological analyses were performed by Envirodyne Engineers and Thermo Analytical (TMA)/Eberline. Analytical results are presented in Appendix G and summarized on Table 8-4.

The results of the major ion chemical analyses were plotted on a trilinear diagram (Figure 8-3) using the method described by Piper (Ref. 32). Examination of the trilinear diagram indicates the following:

- Up-gradient (Wells B-11 and B-23) groundwater chemistry is significantly different from raffinate pit (RP-1, RP-2, and RP-3) water chemistry on all three fields of the diagram.
- Several down-gradient wells (GMW-2A, GMW-3, B-19A, and GMW-5) exhibit water chemistry similar to the raffinate pit water chemistry.
- The distribution of the groundwater chemistry data suggests a mixing relationship with the up-gradient water chemistry (Wells B-11 and B-23) as one end member and an unidentified water chemistry as the other end member.

Evaluation of the analytical results indicates that two of the raffinate pit samples (RP-1 and RP-3) and four of the groundwater samples (Wells B-19A, GMW-2A, GMW-3, and GMW-5) have anion-cation imbalances. The analyses show 20 to 60 percent more cations than anions. The imbalance in the raffinate pit samples appears to be related to the presence of a two-phase system (solid and liquid) in the pits. Equilibrium reactions between the solid and liquid phases proceed at different rates due to variations in chemical solubilities and are frequently disrupted by direct and run-on input of fresh water from precipitation events. The cause of the imbalance in the groundwater samples is not as straightforward. Typically, three causes can be associated with an ionic imbalance. First, failure to analyze for a major constituent may create an apparent imbalance. Since the ionic imbalance indicates a paucity of anions, this would suggest that one or more additional anionic substances may be present. Generally, other anionic substances found in groundwater include orthophosphate, sulfite, tetraborate, and halogens such as iodide and bromide. A second possible explanation for the imbalance involves disruption of equilibrium during and/or after sampling. This disruption can be caused by a variety of mechanisms including biological activity, pressure release (e.g., outgassing of carbon dioxide), or precipitation reactions. A third possible cause involves analytical error which may stem from a variety of causes including interference between ions. For example, sulfite interferes with the determination of chloride, and heavy metals interfere with the determination of sulfate concentrations. One or more of these three causes may have created the observed anionic imbalance.

Selected trace constituents, including lithium, molybdenum, vanadium, total uranium, and radium-226, were also measured from the samples. All of these trace constituents are present in one or more of the raffinate pits in significant concentrations. Groundwater analyses showed the following results:

- Lithium. The highest concentration was observed at Well GMW-3, with detectable concentrations also occurring in Wells B-19A, GMW-2A, and GMW-5.
- Molybdenum. Molybdenum concentrations were not quantified in any groundwater samples.
- Vanadium. The highest vanadium concentration was observed in Well GMW-4, with detectable concentrations also occurring in Wells B-19A and GMW-3.
- Total uranium. The highest total uranium concentration was observed in Well B-4, with elevated concentrations observed in Wells B-2 and B-21.
- Radium-226. The highest radium-226 concentration was observed at Well GMW-18, with elevated concentrations at Wells GMW-1, GMW-10, GMW-13, and GMW-14.

The lithium and vanadium concentrations observed in the groundwater are thought to be derived from the area around the ash pond. Visual observations and the results of the EM survey (Appendix E) indicate that metallic and other debris, both buried and on the surface, are present in the ash pond area. Leaching of these materials may contribute to the elevated levels of trace metals. Boring and trench data for the area northwest of the dike indicate that the residuum layer is 10 to 12 ft below the surface. As discussed in Section 6.0, the ash pond is constructed in a topographic depression. Thus, the base of the ash pond is at or near the top of the residuum. Runoff from the disposal area would transport degrading materials into the ash pond, which could then infiltrate the bedrock aquifer.

The presence of the elevated total uranium concentration in Well B-4 approximately coincides with the high conductivity anomaly identified in the EM survey (Section 8.2). This may also correlate with the elevated radium-226 concentration at Well GMW-18. The main implication of this interpretation is that contamination is migrating to those sites from an up-gradient infiltration source. Since the southeastern end of the site is topographically slightly higher than the adjacent Missouri Conservation Department/Weldon Spring Wildlife Area properties, a possible mechanism to explain this source is suggested. However, more recent groundwater samples collected from Well B-4 have shown background uranium concentrations. Thus, it appears that a longer period for collection of water quality data for this well is needed to understand whether the test results indicate a cyclic condition or a one-time anomalous reading. At Well GMW-18, the uranium and radium in the water must have entered by some route other than vertical infiltration from the ground surface through the clayey overburden, because those clays have a strong affinity for both radium and uranium (Ref. 25). A deep burial area or a presently unknown thin overburden area up-gradient of Well GMW-18 is a likely entry location for the uranium found in the water there. After water level measurements have been made for at least a full year's cycle in that well, the groundwater contours and the up-gradient direction(s) from Well GMW-18 can be refined. Using this information, a search for areas with thin bedrock cover up-gradient of the well can be conducted.

A cement-bond log for Wells B-4 and GMW-18 might indicate that the seal that isolates the well screen from the overburden has deteriorated, so low quality water could enter the well along the annulus.

The elevated radium-226 levels in Wells GMW-10, GMW-13, and GMW-14 appear to be related to the frog pond. The frog pond receives runoff from the northeastern portion of the site. Well GMW-6, located adjacent to the frog pond, indicates that the overburden thickness is approximately 23 ft in this area; however, the frog pond is topographically lower than the well and thus, the overburden beneath the frog pond is less. Seepage may enter the bedrock aquifer beneath the frog pond or in the swampy area downstream from the frog pond. Since the frog pond is located across the groundwater divide as presented on Figures 8-1 and 8-2, the area to which infiltrating water is contributed is also on either side of that divide. However, because the overburden thickness is variable, the water contributed to the groundwater system on one side of the divide may have a quality different from the water on the other side.

Permeabilities measured in Well GMW-6 ranged from 10^{-5} to 10^{-6} cm/s, indicating a set of conditions differing from that of Well GMW-10 in which a permeability of 10^{-3} cm/s was measured. This may explain the absence of radium-226 in Well GMW-6. Similarly, Well GMW-1, located to the west of the ash pond, is in an area of thin overburden cover, and thus may be receiving contaminants from the ash pond area.

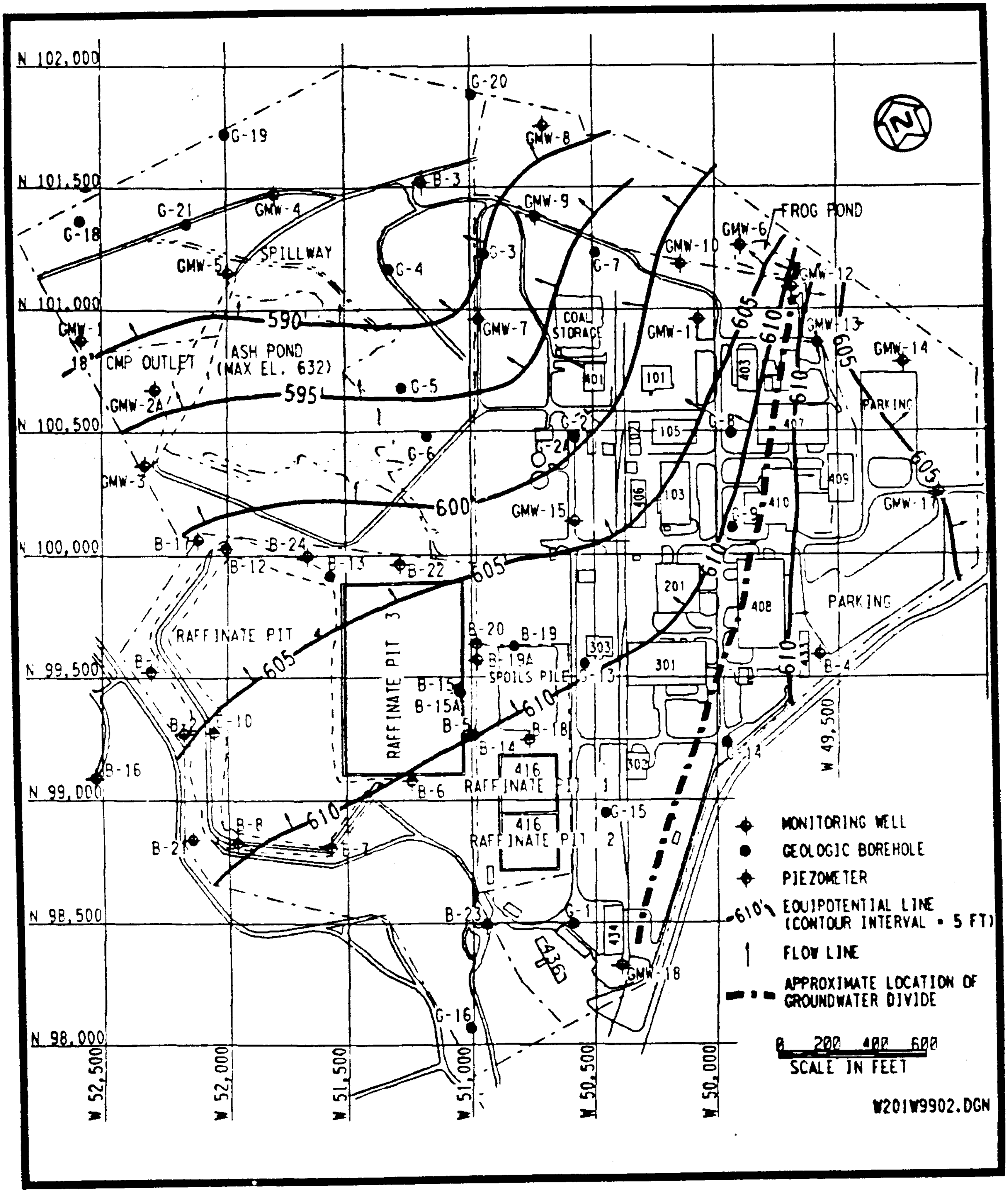


FIGURE 8-1 GROUNDWATER CONTOURS, JULY - AUGUST 1986

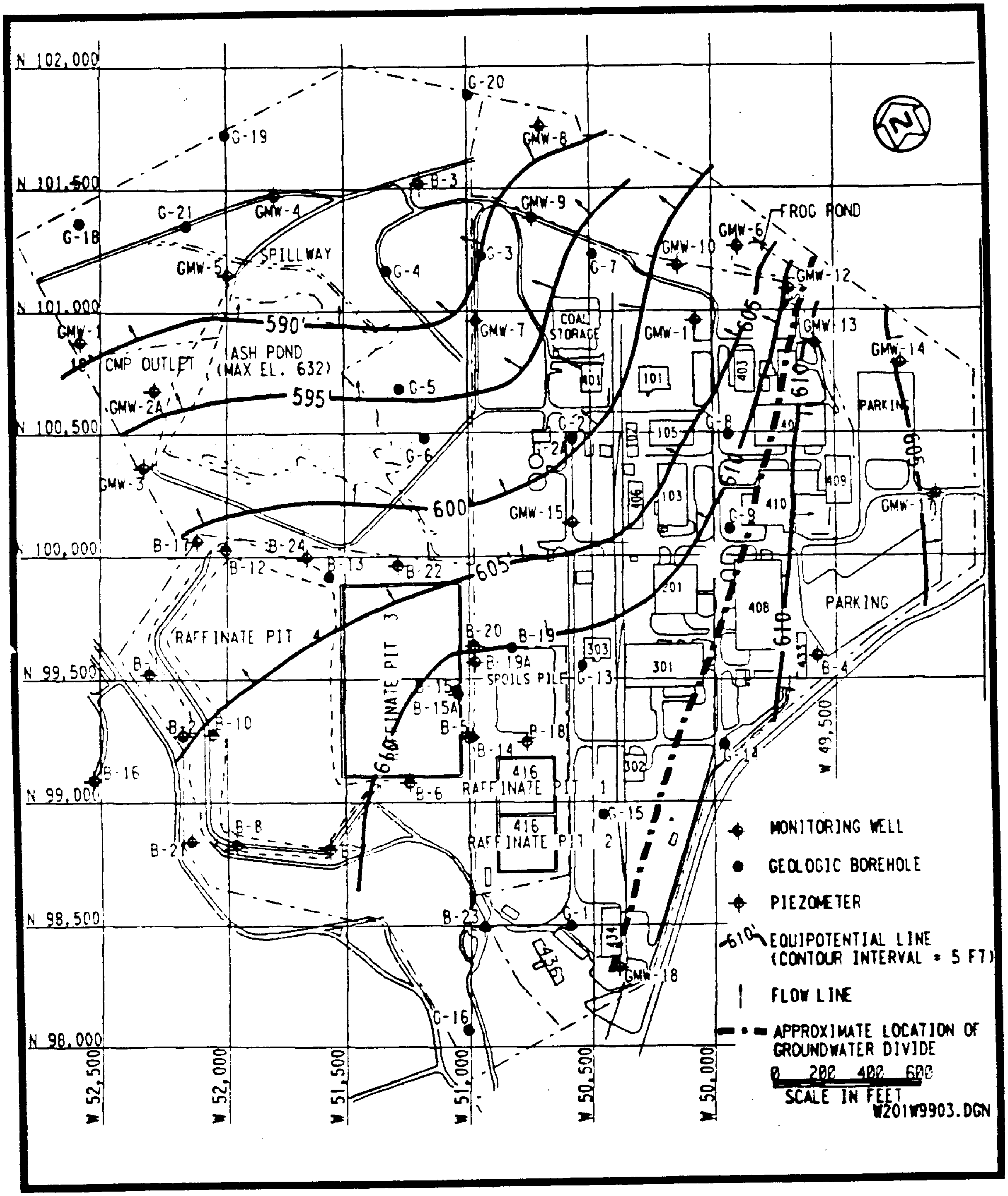


FIGURE 8-2 GROUNDWATER CONTOURS, NOVEMBER 1986

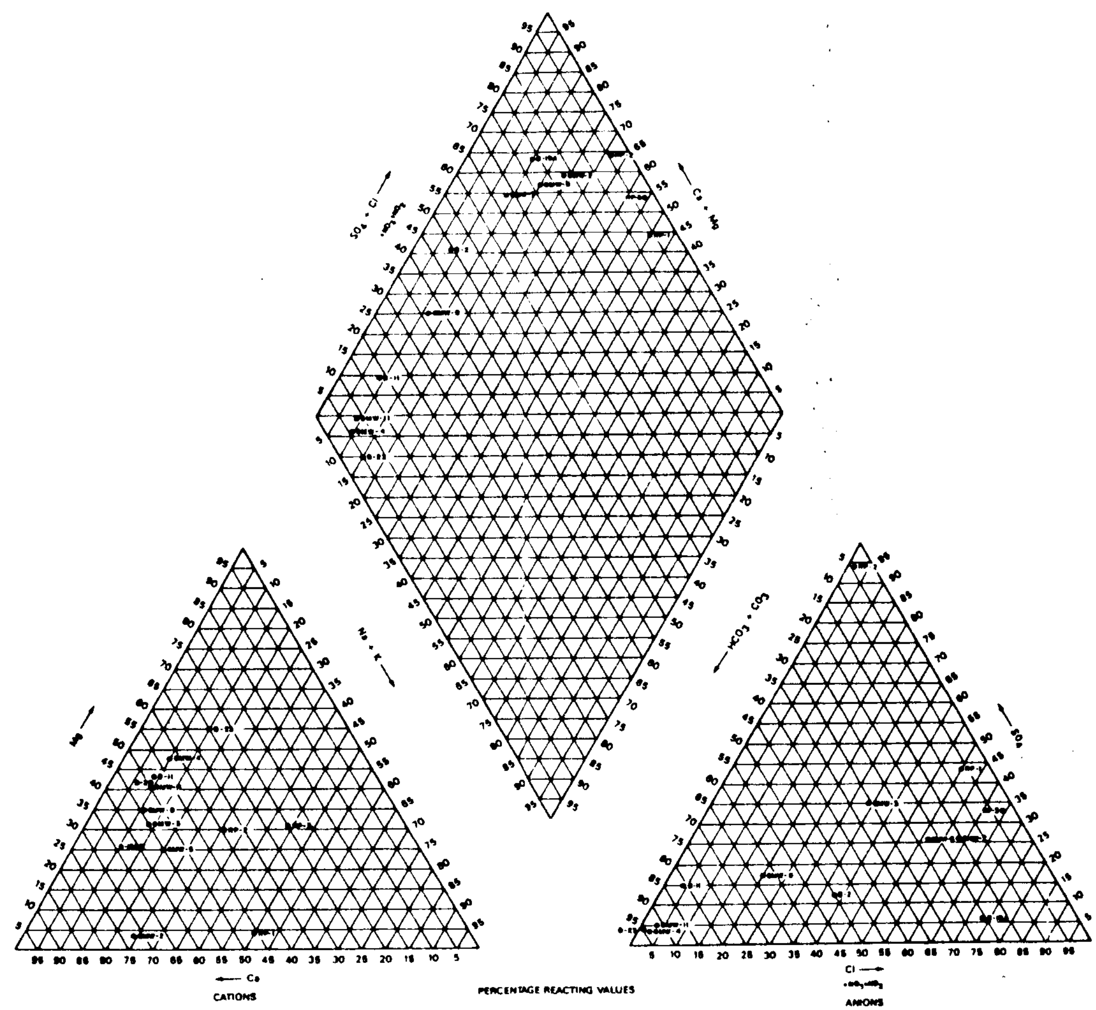


FIGURE 8-3 PIPER TRILINEAR DIAGRAM

TABLE 8-1

PERMEABILITY TEST DATA

Borehole Number	Test Number	Depth Interval (ft)	Permeability (cm/s)	Test Type[a]
Overburden/Bedrock Interface				
G-8	2	30.0 - 32.6	4.7×10^{-3}	CHDP
G-9	1	36.0 - 37.5	9.2×10^{-2}	CHSP
G-16	1	29.0 - 34.0	1.5×10^{-4}	FH
G-19	1	38.0 - 41.5	6.3×10^{-2}	CHSP

Statistics[b]:
n = 4
mean = 3.7×10^{-2}
standard deviation = 4.3×10^{-2}
variance = 1.9×10^{-3}

Borehole Number	Test Number	Depth Interval (ft)	Permeability (cm/s)	Test Type[a]
Unsaturated, Weathered, and Fractured Bedrock				
G-3	1	56.0 - 66.7	1.4×10^{-3}	CHDP
G-7	1	26.9 - 32.8	2.2×10^{-3}	CHDP
G-8	1	31.7 - 37.6	5.4×10^{-3}	CHDP
G-18	1	35.6 - 41.6	8.5×10^{-3}	CHDP
G-20	1	40.0 - 46.0	1.9×10^{-3}	CHDP
GMW-3	2	30.0 - 36.0	3.4×10^{-4}	CHDP
GMW-5	1	38.8 - 44.7	2.2×10^{-3}	CHDP
GMW-9	1	23.0 - 29.0	3.6×10^{-3}	CHDP
GMW-17	1	25.6 - 31.6	4.7×10^{-3}	CHDP
GMW-18	2	30.0 - 36.0	6.8×10^{-6}	CHDP

Statistics[b]:
n = 10
mean = 2.7×10^{-3}
standard deviation = 2.0×10^{-3}
variance = 4.0×10^{-6}

TABLE 8-1

(continued)

Borehole Number	Test Number	Depth Interval (ft)	Permeability (cm/s)	Test Type[a]
Saturated, Weathered, and Fractured Bedrock				
G-1	1	54.0 - 64.7	1.0×10^{-3}	CHDP
G-1	2	64.0 - 74.7	2.8×10^{-4}	CHDP
G-2A	1	56.5 - 67.2	3.5×10^{-4}	CHDP
G-2A	2	67.0 - 77.7	1.2×10^{-4}	CHDP
G-4	1	55.8 - 66.5	1.1×10^{-3}	CHDP
G-5	1	45.3 - 51.3	$<6.4 \times 10^{-7}$	CHDP
G-5	2	55.3 - 61.3	1.3×10^{-6}	CHDP
G-13	1	30.1 - 36.0	5.0×10^{-3}	CHDP
G-15	1	51.0 - 56.3	2.4×10^{-4}	CHDP
G-16	2	45.0 - 50.3	6.1×10^{-3}	CHDP
G-19	2	41.0 - 47.0	8.0×10^{-3}	CHDP
G-20	2	43.0 - 49.0	6.9×10^{-4}	CHDP
GMW-1	1	29.0 - 35.0	$<9.5 \times 10^{-7}$	CHDP
GMW-2A	2	35.2 - 41.2	2.1×10^{-4}	CHDP
GMW-3	1	44.0 - 50.0	$<8.0 \times 10^{-7}$	CHDP
GMW-4	1	52.0 - 58.0	$<9.3 \times 10^{-7}$	CHDP
GMW-4	2	53.6 - 72.0	$<3.9 \times 10^{-7}$	CHSP
GMW-6	1	41.8 - 47.7	8.9×10^{-5}	CHDP
GMW-6	2	32.8 - 38.7	2.6×10^{-6}	CHDP
GMW-8	1	45.0 - 51.0	3.9×10^{-5}	CHDP
GMW-8	2	35.0 - 41.0	3.7×10^{-5}	CHDP
GMW-10	1	40.0 - 46.0	2.1×10^{-3}	CHDP
GMW-11	1	53.5 - 59.5	-c-	CHDP
GMW-13	1	40.0 - 46.0	5.9×10^{-6}	CHDP
GMW-14	1	44.0 - 50.0	2.8×10^{-4}	CHDP
GMW-15	1	50.3 - 56.2	9.1×10^{-3}	CHDP

TABLE 8-1

(continued)

Borehole Number	Test Number	Depth Interval (ft)	Permeability (cm/s)	Test Type[a]
GMW-15	1	62.3 - 68.2	5.2×10^{-5}	CHDP
GMW-18	1	42.0 - 48.0	8.9×10^{-5}	CHDP

Statistics[b]:
n = 22
mean = 1.6×10^{-3}
standard deviation = 2.8×10^{-3}
variance = 7.8×10^{-6}

Slightly Weathered to Fresh Bedrock

Borehole Number	Test Number	Depth Interval (ft)	Permeability (cm/s)	Test Type[a]
G-9	2	66.0 - 76.0	3.6×10^{-6}	CHSP
G-14	1	64.0 - 76.4	$<3.5 \times 10^{-7}$	CHSP
G-19	3	51.0 - 57.0	$<7.8 \times 10^{-7}$	CHDP
G-21	1	58.5 - 74.5	2.1×10^{-6}	CHSP
GMW-2A	1	51.8 - 57.8	$<6.8 \times 10^{-7}$	CHDP
GMW-7	1	62.0 - 68.0	8.2×10^{-7}	CHDP
GMW-12	1	52.0 - 58.0	1.7×10^{-5}	CHDP
GMW-13	2	62.0 - 68.0	5.2×10^{-6}	CHDP

Statistics[b]:
n = 5
mean = 5.7×10^{-6}
standard deviation = 6.5×10^{-6}
variance = 4.2×10^{-11}

[a]Test Type:

CHDP = Constant Head Double Packer Pressure Test

CHSP = Constant Head Single Packer Pressure Test

FH = Falling Head Test

TABLE 8-1

(continued)

[b]Statistics:

n = number of samples used for evaluation (tests with values reported as less than (<) were not included in the statistical evaluation

[c]The high water take on this test resulted in a head loss greater than the total head for the test and thus the test is considered invalid.

TABLE 8-2

MONITORING WELL SUMMARY

Well Number	Reference Elevation	Depth of Well (ft)	Monitoring Interval[a] (ft)	Well Completion[b]	Monitoring Zone
B-2	633.08	26.8	18.8 - 25.8	2-in. PVC screen	Clayey silt/glacial till
B-3	637.08	150.5	62.7 - 145.6	2-in. PVC screen	Burlington/Keokuk formation
B-4	657.00	119.6	36.5 - 119.6	3-in. Open hole	Burlington/Keokuk formation
B-9	635.38	84.7	41.0 - 84.7	3-in. Open hole	Burlington/Keokuk formation
B-11	671.78	106.2	51.0 - 106.2	3-in. Open Hole	Burlington/Keokuk formation
B-14	655.62	21.8	13.7 - 21.1	2-in. PVC screen	Silty clay/glacial till
B-15A	665.66	32.0	24.25 - 32.0	2-in. PVC screen	Silty clay/glacial till
B-16	623.06	28.5	20.5 - 26.5	2-in. PVC screen	Residuum
B-17	646.44	99.1	39.0 - 99.1	3-in. Open hole	Burlington/Keokuk formation
B-19A	648.18	101.0	39.0 - 101.0	3-in. Open hole	Burlington/Keokuk formation
B-21	646.52	99.4	45.0 - 99.4	3-in. Open hole	Burlington/Keokuk formation
B-23	667.01	90.7	52.5 - 90.7	3-in. Open hole	Burlington/Keokuk formation
B-24	652.14	23.5	20.0 - 23.0	2-in. PVC screen	Glacial till
GMW-1	614.10	59.0	31.6 - 58.0	2-in. Stainless steel screen	Burlington/Keokuk formation
GMW-2A	626.00	59.0	31.7 - 58.0	2-in. Stainless steel screen	Burlington/Keokuk formation
GMW-3	638.80	59.0	41.5 - 58.0	2-in. Stainless steel screen	Burlington/Keokuk formation
GMW-4	644.80	76.5	54.3 - 75.5	2-in. Stainless steel screen	Burlington/Keokuk formation
GMW-5	637.70	76.5	50.0 - 75.5	2-in. Stainless steel screen	Burlington/Keokuk formation
GMW-6	635.80	66.5	27.0 - 65.5	2-in. Stainless steel screen	Burlington/Keokuk formation
GMW-7	651.00	94.0	62.3 - 93.0	2-in. Stainless steel screen	Burlington/Keokuk formation
GMW-8	621.90	56.5	34.0 - 55.5	2-in. Stainless steel screen	Burlington/Keokuk formation
GMW-9	639.10	58.6	27.2 - 57.6	2-in. Stainless steel screen	Burlington/Keokuk formation
GMW-10	644.10	59.0	37.2 - 58.0	2-in. Stainless steel screen	Burlington/Keokuk formation
GMW-11	655.20	73.8	36.6 - 72.8	2-in. Stainless steel screen	Burlington/Keokuk formation
GMW-12	638.20	59.0	29.3 - 58.0	2-in. Stainless steel screen	Burlington/Keokuk formation
GMW-13	647.40	69.0	31.3 - 68.0	2-in. Stainless steel screen	Burlington/Keokuk formation
GMW-14	649.40	59.0	37.0 - 58.0	2-in. Stainless steel screen	Burlington/Keokuk formation
GMW-15	659.90	78.5	47.3 - 77.5	2-in. Stainless steel screen	Burlington/Keokuk formation

TABLE 8-2

(continued)

Well Number	Reference Elevation	Depth of Well (ft)	Monitoring Interval[a] (ft)	Well Completion[b]	Monitoring Zone
GMW-17	659.90	64.0	30.0 - 63.0	2-in. stainless steel screen	Burlington/Keokuk formation
GMW-18	663.50	64.0	37.4 - 63.0	2-in. stainless steel screen	Burlington/Keokuk formation

[a]Monitoring Interval: For wells with screens, the monitoring interval is defined by the depth to the bottom of the bentonite seal and the depth to the bottom of the screen. For wells with open hole completion, the monitoring interval is defined as the depth of the bottom of the surface casing and the depth of the bottom of the well.

[b]Well Completion:

2-in. PVC screen = diameter polyvinylchloride riser pipe, #40 slot screen, and sump with filter pack and bentonite seal.

3-in. open hole = 4-in.-diameter polyvinylchloride surface casing cemented into the bedrock with 3-in.-diameter open hole below.

2-in. stainless steel screen = 2-in.-diameter type 3166 stainless steel riser pipe, #10 slot screen, and 1-ft sump, with filter pack and bentonite seal.

TABLE 8-3

GROUNDWATER ELEVATIONS

Well Number	07/24-30/86	11/01/86
GMW-1	588.86	589.15
GMW-2A	593.71	594.13
GMW-3	597.98	597.92
GMW-4	584.56	583.97
GMW-5	588.26	588.23
GMW-6	601.54	601.85
GMW-7	590.36	590.26
GMW-8	585.98	585.91
GMW-9	597.96	597.81
GMW-10	600.46	600.85
GMW-11	600.72	600.80
GMW-12	610.43	612.12
GMW-13	605.26	607.98
GMW-14	604.45	604.25
GMW-15	603.99	603.54
GMW-17	605.51	604.85
GMW-18	615.43	614.80
B-3	580.41	574.49
B-4	607.92	607.60
B-17	599.61	600.42
B-19A	608.70	610.84
B-21	607.77	607.22
B-23	612.84	612.23

TABLE 8-4

HYDROGEOCHEMICAL DATA

Page 1 of 5

Monitoring Point Parameter[a]	Raffinate Pit 1	Raffinate Pit 2	Raffinate Pit 3	Well B-2	Well B-4
Calcium (mg/l)	361	101	420	102	ND
Magnesium (mg/l)	19.2	46.9	311	53.9	ND
Sodium (mg/l)	420	78	767	19.4	ND
Potassium (mg/l)	38	20	105.95	1.24	ND
Lithium (mg/l)	BQL	BQL	2.79	BQL	ND
Molybdenum (mg/l)	3.34	6.67	3.96	BQL	ND
Strontium (mg/l)	1.04	0.353	1.76	0.212	ND
Vanadium (mg/l)	2.38	1.41	0.548	BQL	ND
Total Uranium (ppb)	41	130	130	26	28
Radium-226 (pCi/l)	57 ± 6	40 ± 4	120 ± 10	0.6 ± 0.1	BQL
Carbonate (mg/l)	BQL	BQL	BQL	BQL	ND
Bicarbonate (mg/l)	50.8	39	50	128.6	ND
Sulfate (mg/l)	315	796	495	26	ND
Chloride (mg/l)	27.2	6.2	36.3	4	ND
Nitrate (mg/l)	404	10.13	1170	88.8	ND
Nitrite (mg/l)	1.78	0.55	2.69	BQL	ND
Hardness (mg/l as $CaCO_3$)	936	470	2461	493	ND
Conductivity (μmhos/cm)	3515.8	425.5	9449.5	977.1	ND
pH	8.01	8.63	8.06	7.90	ND
ORP[b] (mv)	300	278	354	298	ND
Gross Alpha (pCi/l)	190 ± 40	590 ± 50	230 ± 50	11 ± 6	16 ± 9
Gross Beta (pCi/l)	91 ± 12	250 ± 20	410 ± 30	9 ± 7	0 ± 5

TABLE 8-4

(Continued)

Monitoring Point Parameter[a]	Well B-11	Well B-17	Well B-19A	Well B-21	Well B-23
Calcium (mg/l)	61.9	ND	951	ND	47
Magnesium (mg/l)	34.5	ND	250	ND	53.1
Sodium (mg/l)	11	ND	284	ND	26.3
Potassium (mg/l)	1.18	ND	3.54	ND	17.54
Lithium (mg/l)	BQL	ND	0.22	ND	BQL
Molybdenum (mg/l)	BQL	ND	BQL	ND	BQL
Strontium (mg/l)	0.103	ND	2.57	ND	0.210
Vanadium (mg/l)	BQL	ND	0.064	ND	BQL
Total Uranium (ppb)	BQL	7	5	26	ND
Radium-226 (pCi/l)	0.3 ± 0.1	0.6 ± 0.1	0.2 ± 0.1	BQL	ND
Carbonate (mg/l)	BQL	ND	BQL	ND	BQL
Bicarbonate (mg/l)	260.4	ND	251.6	ND	365
Sulfate (mg/l)	38	ND	57	ND	13
Chloride (mg/l)	6.8	ND	22.1	ND	1.7
Nitrate (mg/l)	1.5	ND	870	ND	1.10
Nitrite (mg/l)	BQL	ND	0.06	ND	BQL
Hardness (mg/l as $CaCO_3$)	286	ND	3448	ND	340
Conductivity (μmhos/cm)	450.0	ND	7368.4	ND	7352.8
pH	8.11	7.10	7.17	ND	8.18
ORP[b] (mv)	268	ND	336	ND	300
Gross Alpha (pCi/l)	15 ± 5	BQL	BQL	9 ± 4	ND
Gross Beta (pCi/l)	22 ± 6	76 ± 9	BQL	12 ± 3	ND

TABLE 8-4

(Continued)

Monitoring Point Parameter[a]	Well GMW-1	Well GMW-2A	Well GMW-3	Well GMW-4	Well GMW-5
Calcium (mg/l)	ND	210	235	59.2	182
Magnesium (mg/l)	ND	5.45	84.6	39.6	49
Sodium (mg/l)	ND	70.2	57.2	14.4	71.5
Potassium (mg/l)	ND	17.54	10.54	1.76	9.96
Lithium (mg/l)	ND	0.21	0.45	BQL	0.27
Molybdenum (mg/l)	ND	BQL	BQL	BQL	BQL
Strontium (mg/l)	ND	0.610	0.723	0.305	0.722
Vanadium (mg/l)	ND	BQL	0.025	0.084	BQL
Total Uranium (ppb)	11	BQL	BQL	BQL	BQL
Radium-226 (pCi/l)	3.5 ± 0.8	0.3 ± 0.1	0.5 ± 0.1	0.3 ± 0.1	0.5 ± 0.1
Carbonate (mg/l)	ND	BQL	BQL	BQL	BQL
Bicarbonate (mg/l)	ND	49.8	237.8	350	83.2
Sulfate (mg/l)	ND	64	210	13	76
Chloride (mg/l)	ND	7.9	13	4	9.6
Nitrate (mg/l)	ND	167	236	1.20	185
Nitrite (mg/l)	ND	0.82	BQL	BQL	BQL
Hardness (mg/l as $CaCO_3$)	ND	547	962	320	656
Conductivity (μmhos/cm)	ND	1601.6	2551.4	619.9	1794.7
pH	ND	7.35	7.81	7.81	7.64
ORP[b] (mv)	ND	333	308	229	321
Gross Alpha (pCi/l)	25 ± 9	BQL	BQL	BQL	BQL
Gross Beta (pCi/l)	18 ± 4	26 ± 77	20 ± 8	BQL	21 ± 8

TABLE 8-4

(Continued)

Page 4 of 5

Monitoring Point Parameter[a]	Well GMW-6	Well GMW-7	Well GMW-8	Well GMW-9	Well GMW-10	Well GMW-11
Calcium (mg/l)	ND	ND	83.1	ND	ND	61.3
Magnesium (mg/l)	ND	ND	33.1	ND	ND	30.7
Sodium (mg/l)	ND	ND	18.0	ND	ND	10.4
Potassium (mg/l)	ND	ND	3.13	ND	ND	3.76
Lithium (mg/l)	ND	ND	BQL	ND	ND	BQL
Molybdenum (mg/l)	ND	ND	BQL	ND	ND	BQL
Strontium (mg/l)	ND	ND	0.246	ND	ND	0.116
Vanadium (mg/l)	ND	ND	BQL	ND	ND	BQL
Total Uranium (ppb)	4	11	BQL	6	7	ND
Radium-226 (pCi/l)	BQL	BQL	BQL	BQL	3.3 ± 0.6	ND
Carbonate (mg/l)	ND	ND	BQL	ND	ND	BQL
Bicarbonate (mg/l)	ND	ND	271	ND	ND	295
Sulfate (mg/l)	ND	ND	59	ND	ND	12
Chloride (mg/l)	ND	ND	50.4	ND	ND	2.8
Nitrate (mg/l)	ND	ND	BQL	ND	ND	4.13
Nitrite (mg/l)	ND	ND	BQL	ND	ND	BQL
Hardness (mg/l as $CaCO_3$)	ND	ND	356	ND	ND	438
Conductivity (μmhos/cm)	ND	ND	6837.0	ND	ND	5597.9
pH	ND	ND	7.76	ND	ND	7.90
ORP[b] (mv)	ND	ND	298	ND	ND	297
Gross Alpha (pCi/l)	BQL	14 ± 8	BQL	6 ± 5	12 ± 7	ND
Gross Beta (pCi/l)	13 ± 3	15 ± 3	17 ± 7	5 ± 3	8 ± 3	ND

TABLE 8-4

(Continued)

Monitoring Point Parameter[a]	Well GMW-12	Well GMW-13	Well GMW-14	Well GMW-15	Well GMW-18
Calcium (mg/l)	ND	ND	ND	ND	ND
Magnesium (mg/l)	ND	ND	ND	ND	ND
Sodium (mg/l)	ND	ND	ND	ND	ND
Potassium (mg/l)	ND	ND	ND	ND	ND
Lithium (mg/l)	ND	ND	ND	ND	ND
Molybdenum (mg/l)	ND	ND	ND	ND	ND
Strontium (mg/l)	ND	ND	ND	ND	ND
Vanadium (mg/l)	ND	ND	ND	ND	ND
Total Uranium (ppb)	3	9	9	8	11
Radium-226 (pCi/l)	BQL	2.0 ± 0.6	2.2 + 0.8	BQL	5.3 ± 0.9
Carbonate (mg/l)	ND	ND	ND	ND	ND
Bicarbonate (mg/l)	ND	ND	ND	ND	ND
Sulfate (mg/l)	ND	ND	ND	ND	ND
Chloride (mg/l)	ND	ND	ND	ND	ND
Nitrate (mg/l)	ND	ND	ND	ND	ND
Nitrite (mg/l)	ND	ND	ND	ND	ND
Hardness (mg/l as $CaCO_3$)	ND	ND	ND	ND	ND
Conductivity (μmhos/cm)	ND	ND	ND	ND	ND
pH	ND	ND	ND	ND	ND
ORP[b] (mv)	ND	ND	ND	ND	ND
Gross Alpha (pCi/l)	BQL	10 ± 7	10 ± 5	BQL	19 ± 9
Gross Beta (pCi/l)	BQL	8 ± 3	6 ± 3	4 ± 3	23 ± 4

[a]BQL = Below Method Quantitation Limit
ND = Not Determined

[b]Oxidation-Reduction Potential or Redox

9.0 FINDINGS

To synthesize the results of this investigation, the following subsections address the objectives of the investigation as outlined in Section 2.1.

9.1 GROUNDWATER MONITORING SYSTEM

Groundwater monitoring at the site appears to be complicated by the presence of a groundwater divide which creates two distinct down-gradient directions. Monitoring wells were installed to monitor both down-gradient directions. Results of preliminary groundwater sampling and analysis indicate that surface runoff is likely to be the primary transport agent for degrading materials, with infiltration of runoff to the groundwater system as a secondary mechanism.

9.2 WASTE CONTAINMENT DESIGN

Evaluation of geological data from the site indicates several favorable features for waste containment design:

- Areas of thick overburden deposits are present.
- The clay till and Ferrelview Formation exhibit good sorbtive characteristics for radionuclides.
- Based upon the raffinate pit and ash pond dike performance, the native soils are stable when used to construct engineered slopes.
- Bedrock coring indicates the absence of large solution cavities which might affect the stability of a waste containment structure.

Evaluation of the hydrogeological information also suggests that the groundwater system is restricted to the upper portion of the bedrock and, in some cases, the residuum layer. Thus, the unsaturated zone, in the areas of the thickest overburden, ranges from 30 to 50 ft in thickness.

The geological and hydrogeological data also indicate several unfavorable features for waste containment design:

- Areas of the site where the overburden is thin have the basal till and/or residuum units exposed, both of which may have poorer sorptive characteristics.
- The uppermost aquifer is composed of fractured and solutioned limestone which would provide a pathway for transport of contaminants off-site, if these contaminants were to reach the bedrock.
- The fractured nature of the aquifer adds additional complexity to the design of a permanent groundwater monitoring system with respect to locating the wells in the interconnected fractures which form the aquifer.
- The presence of a groundwater divide at the site would require installation of a larger number of permanent groundwater monitoring wells to allow monitoring of both down-gradient directions.

The data collected in this investigation does not preclude the use of this site as a long-term storage facility. However, detailed investigations of the selected waste containment area and longer term monitoring of hydrogeochemistry and groundwater levels are recommended prior to final site selection.

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APPENDIX A
BORING LOGS

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	1 of 3	G-1

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
ADJACENT TO BUILDING 435	N98,473.2 W50,501.0	90	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
1/28/86	1/31/86	TONY CALTRY BROTCKE ENGINEERING	CME-55 ATV	6 1/4"/3"	39.7	44.3	84.0 FT

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
38.5/89	4	9	-	668.0	53.23 FT/614.77	39.7 FT/628.3

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 LBS/30 IN	NONE	LAWRENCE YOUNG

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS % PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M. (1ST 6")	PRESSURE P.S.I. (2ND 6")	TIME IN MINUTES (3RD 6")	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							668.0	0				
							667.0	1			0-1.0 FT GRAVEL, LIGHT GRAY (N7), LIMESTONE, SOME CLAY AND ORGANIC MATERIAL.	0-45.3 FT DRILLED WITH 6¼IN OD HOLLOW STEM AUGERS.
											1.0-4.5 FT CLAYEY SILT, BLACK (N1), SOFT, MOIST, ORGANIC DEBRIS.	
							663.5	4.5				
SS 2"	18"	18"	17	4	7	10		5		1	4.5-39.7 FT CLAYEY SILT, MODERATE YELLOWISH BROWN (10YR 5/4) TO DARK YELLOWISH BROWN (10YR 4/2), STIFF TO HARD, MOIST, WITH MEDIUM GRAY (N5) SILT LENSES, TRACE TO SOME GRAVEL AND COBBLES.	
SS 2"	18"	18"	10	3	4	6		10		2		DRIVING COBBLE.
SS 2"	18"	18"	16	4	6	10		15		3		
SS 2"	18"	18"	26	6	11	15		20		4		
SS 2"	18"	18"	40	9	18	22		25		5		
SS 2"	18"	18"	32	10	14	18		30		6		
							633.0	35				

SS-SPLIT SPOON; ST-SHELBY TUBE; D-DENISON; P-PITCHER; O-OTHER	SITE	HOLE NO.
	ADJACENT TO BUILDING 435	G-1

BECHTEL

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	2 of 3	G-1

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M. (1ST 6")	WATER PRESSURE TESTS: PRESSURE P.S.I. (2ND 6")	WATER PRESSURE TESTS: TIME IN MINUTES (3RD 6")	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							633.0	35				
ST 2"	18"	18"	24	7	11	13				7		BOREHOLE WAS RADIOLOGICALLY LOGGED BY EBERLINE ANALYTICAL CORPORATION PRIOR TO CORING.
SS 2"	18"	11"	76	27	34	42	628.3	39.7 40		8	39.7-45.3 FT LIMESTONE, VERY LIGHT GRAY (N8), VERY SOFT, DECOMPOSED, DRY, CONTAINS CLASTS OF LESS WEATHERED LIMESTONE.	BURLINGTON/KEOKUK FORMATION.
ST 2"	10"	7"	50+	20	50/4"	-	622.7	45 45.3		9	45.3-79.5 FT LIMESTONE, LIGHT GRAY (N7) TO DARK YELLOWISH ORANGE (10YR 6/6), SOFT TO HARD, HIGHLY TO MODERATELY WEATHERED, VUGGY, IRON STAINED, VUGS RANGE IN SIZE FROM 4CM TO LESS THAN 0.5CM. UPPER 2 FT OF CORE CONTAIN HEALED FRACTURES ORIENTED FROM 0-20° RELATIVE TO CORE AXIS. REMAINDER OF UNIT CONTAINS HORIZONTAL FRACTURES, ROUGH PLANAR APERATURE, IRON STAINED, SOME CONTAIN CLAY FILLING. FRACTURE SPACING VARIES FROM 0.1-0.5 FT.	SAMPLER REFUSAL. 45.3-84.0 FT DRILLED WITH NO DIAMOND CORE BARREL USING WATER
NO CORE	8.5	5.0	59%					50		RUN #1		RUN #1 ROD = 66% LP = 0.8 FT AP = 0.5 FT ▽ 1/30/86
NO CORE	10.0	9.6	96%	17.0 17.5 18.5 19	5 9 13 18	9 4 6 6		55 60		RUN #2		RUN #2 ROD = 66% LP = 0.8 FT AP = 0.3 FT
NO CORE	10.0	9.8	98%	1.5 8	22 29	4 15		65 70		RUN #3		RUN #3 ROD = 55% LP = 0.8 FT AP = 0.3 FT
							593.0	75				

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENNISON; P=PITCHER; O=OTHER	SITE: ADJACENT TO BUILDING 435	HOLE NO. G-1

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	3 of 3	G-1

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							593.0	75				
NO CORE	10.0	10.0	100%				588.5	79.5 / 80		RUN #4	79.5-84.0 FT LIMESTONE, MEDIUM LIGHT GRAY (N6), HARD, MASSIVE, STYLOLITIC, CORE BREAKS ALONG STYLOLITES, THIN (0.2 FT) CHERT LAYERS.	RUN #4 RQD = 75% AP = 0.4 FT LP = 1.5 FT
							584.0	84			BOTTOM OF BORING AT 84.0 FT. BORING GROUTED TO SURFACE ON 1/31/86.	RQD=ROCK QUALITY DESIGNATION FOR EACH RUN. AP=AVERAGE LENGTH OF CORE PIECES. LP=LONGEST PIECE OF CORE FROM EACH RUN. ALL SOIL AND ROCK COLOR DESCRIPTIONS FROM THE ROCK COLOR CHART PRINTED BY THE GEOLOGICAL SOCIETY OF AMERICA.

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENNISON; P=PITCHER; O=OTHER	SITE	HOLE NO.
	ADJACENT TO BUILDING 435	G-1

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	1 of 2	G-2

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
EAST OF BUILDING 428	N100,449.9 E50,577.3	90	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
1/29/86	2/6/86	TONY CALTRY BROTCKE ENGINEERING	CME-55 ATV	6 1/4"/3"	42.5	21.5	64.0 FT

CORE RECOVERY(FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
9.9/52	2	9	-	657.9	NOT MEASURED	42.5 FT/615.4

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 LBS/30 IN	NONE	LAURENCE YOUNG

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS % PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M. (1ST 6")	PRESSURE P.S.I. (2ND 6")	TIME IN MINUTES (3RD 6")	ELEVATION	DEPTH	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							657.9	0			
							657.4	0.5		0-0.5 FT GRAVEL, LIGHT GRAY (N7), LIMESTONE.	0-44.8 FT DRILLED WITH 6 1/4 IN OD HOLLOW STEM AUGERS.
							656.4	1.5		0.5-1.5 FT CLAYEY SILT, BLACK (N1), SOFT, MOIST, ORGANIC DEBRIS.	
SS 2"	18"	13"	22	6	10	12		5	1	1.5-32.5 FT CLAYEY SILT, MODERATE BROWN (5YR 3/4), STIFF TO HARD, MOIST, WITH MEDIUM GRAY (N5) SILT LENSES, TRACE TO SOME SUB-ROUNDED GRAVEL.	
											DRIVING COBBLE.
SS 2"	18"	16"	22	7	10	12		10	2		
SS 2"	18"	18"	23	5	10	13		15	3		
SS 2"	18"	17"	30	8	14	16		20	4		
SS 2"	18"	20"	20	6	9	11		25	5		
SS 2"	18"	20"	24	7	10	14		30	6		
							625.4	32.5		32.5-35.5 FT SILT, MODERATE YELLOWISH BROWN (10YR 5/6), STIFF, MOIST, SOME SUB-ROUNDED GRAVEL.	
							622.9	35			

SS=SPLIT SPOON, ST=SHELBY TUBE, D=DENISON, P=PITCHER, O=OTHER	SITE	HOLE NO.
	EAST OF BUILDING 428	G-2

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	2 OF 2	G-2

Sample type and diameter	Sampler advance (Depth core run)	Sample recovery (Core recovery)	Sample blows 6" / Percent core recovery	Water pressure tests: Loss in G.P.M.	Pressure P.S.I.	Time in minutes	Elevation	Depth	Sample	Description and classification	Notes on: water levels, water return, character of drilling, etc.
				1ST 6"	2ND 6"	3RD 6"	622.9	35			
SS 2"	11"	10"	50+	19	50/5"	-	622.4	35.5	7	35.5-38.0 FT SILT AND GRAVEL, MODERATE BROWN (5YR 3/4), STIFF, MOIST, SILT AND ANGULAR CHERT GRAVEL.	BOREHOLE WAS RADIOLOGICALLY LOGGED BY EBERLINE ANALYTICAL CORPORATION PRIOR TO CORING.
							619.9	38		38.0-42.5 FT CLAYEY SILT, MODERATE BROWN (5YR 3/4), VERY STIFF, MOIST, TRACE TO SOME ANGULAR CHERT GRAVEL.	
SS 2"	18"	23"	21	9	10	11		40	8		
							615.4	42.5		42.5-44.8 FT LIMESTONE, VERY LIGHT GRAY (N8), SOFT, EXTREMELY WEATHERED, CHERT FRAGMENTS.	BURLINGTON/KEOKUK FORMATION. 44.8 FT SAMPLER REFUSAL.
SS 2"	3"	4"	50+	50/3"	-		612.9	45			
NQ CORE	1.0	0.4	40						RUN #1	44.8-64.0 FT LIMESTONE, DARK YELLOWISH ORANGE (10YR 6/6) TO VERY LIGHT GRAY (N8), MEDIUM SOFT TO HARD, HIGHLY WEATHERED, VUGGY, 0.5 TO 0.8 FT CHERT LAYERS, HORIZONTALLY FRACTURED, SMOOTH PLANAR SURFACE, IRON STAINING ON FRACTURE MARGINS, FRACTURES FILLED WITH SILT AND CLAY.	RUN #1 RQD = 0 % AP = 0.05 FT LP = 0.2 FT
NQ CORE	7.0	0.9	13					50	RUN #2		RUN #2 RQD = 0 % AP = 0.05 FT LP = 0.2 FT
NQ CORE	5.0	3.2	64					55	RUN #3		RUN #3 RQD = 36% AP = 0.2 FT LP = 0.5 FT RUN #4 RQD = 25% AP = 0.1 FT LP = 0.6 FT
NQ CORE	6.0	5.4	90					60	RUN #4	60.0-64.0 FT STYLOLITES.	44.8-64.0 FT DRILLED WITH NQ DIAMOND CORE DRILL WITH WATER.
							553.9	64		BOTTOM OF BORING AT 64.0 FT. BORING ABANDONED AND REPLACED BY BORING G-2A. BORING GROUTED TO SURFACE ON 2/6/86.	RQD=ROCK QUALITY DESIGNATION FOR EACH RUN. AP=AVERAGE LENGTH OF CORE PIECES. LP=LONGEST PIECE OF CORE FROM EACH RUN. ALL SOIL AND ROCK COLOR DESCRIPTIONS FROM THE ROCK COLOR CHART PRINTED BY THE GEOLOGICAL SOCIETY OF AMERICA.

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER

SITE	HOLE NO.
EAST OF BUILDING 428	G-2

BECHTEL

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	1 of 3	G-2A

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
EAST OF BUILDING 428	N100,440.0 W50,578.1	90	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT)	ROCK (FT)	TOTAL DEPTH
2/4/86	2/6/86	TONY CALTRY BROTCKE ENGINEERING	CME-55 ATV	6 1/4"/3"	45.0	38.0	83.0 FT

CORE RECOVERY(FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
25.9/86	3	-	-	658.0	53.2 FT/604.8	45.0 FT/613.0

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
-	NONE	LAWRENCE YOUNG

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS OR PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							658.0	0				
HOLLOW STEM AUGERS - NO SAMPLES												0-53.0 FT DRILLED WITH 6-1/4 IN O.D. HOLLOW STEM AUGERS.
								5				
								10				
								15				
								20				
								25				
								30				
							623.0	35				

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER	SITE	HOLE NO.
	EAST OF BUILDING 428	G-2A

GEOLOGIC DRILL LOG	PROJECT: FUSRAP - WELDON SPRING SITE	JOB NO. 14501-201	SHEET NO. 2 OF 3	HOLE NO. G-2A

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I	TIME IN MINUTES	ELEVATION	DEPTH	SAMPLE	DESCRIPTION AND CLASSIFICATION
							623.0	35		
								40		
								45		
								50		
NO CORE	6.5'	4.3'	66				605.0	53	RUN #1	53.0-71.7 FT LIMESTONE, DARK YELLOWISH ORANGE (10YR 6/6), SOFT, HIGHLY WEATHERED, 0.4 TO 0.6 FT CHERT LAYERS, HORIZONTAL FRACTURES, SILT AND CLAY FILLING, ROUGH-PLANAR APERTURE.
	0.6'	0.4'	67	5.0	9.5	32		60	#2	60.3-60.5 FT FOSSILTEROUS ZONE.
NO CORE	2.9'	2.9'	100	7.4	15.0	10			RUN #3	62.4 FT FRACTURE ORIENTED 50° RELATIVE TO CORE AXIS, IRON STAINED, ROUGH-PLANAR SURFACE.
NO CORE	10.0'	8.7'	87	1.8	16.0	12		65 / 70	RUN #4	
				2.4	18.0	14				
				8.6	22.0	14	586.3	71.7		71.7-80.8 FT LIMESTONE, MEDIUM DARK GRAY (N4) TO MEDIUM LIGHT GRAY (N6), HARD, SLIGHTLY WEATHERED WITH DARK YELLOWISH BROWN (10YR 4/2) SHALE LAYERS,
							583.0	75		

NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.

REPLACEMENT BORING FOR BOREHOLE G-2. ADVANCED WITHOUT SAMPLING TO 53.0 FT. SEE LOG OF BORING G-2 FOR MATERIAL DESCRIPTION FROM 0-53.0 FT.

53.0-83.0 FT CORED WITH NO WIRE LINE CORE DRILL USING WATER.

▽ 2/5/86

BURLINGTON/KEOKUK FORMATION

RUN #1
RQD = 52%
AP = 0.2 FT
LP = 0.4 FT

RUN #2
RQD = 0 %
AP = 0.1 FT
LP = 0.15 FT

RUN #3
RQD = 34%
AP = 0.3 FT
LP = 0.5 FT

RUN #4
RQD = 70%
AP = 0.4 FT
LP = 1.3 FT

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENNISON; P=PITCHER; O=OTHER

SITE: EAST OF BUILDING 428 — HOLE NO. G-2A

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	3 OF 3	G-2A

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							583.0	75			SOFT, 0.1 TO 0.5 FT THICK, HORIZONTALLY FRACTURED WITH ROUGH-PLANAR SURFACES, VUGGY, OCCASIONAL STYLOLITES.	
NO CORE	10.0	9.6'	96					80		RUN #5		RUN #5 RQD = 96% AP = 0.8 FT LP = 1.6 FT
							577.2	80.8			80.8-83.0 FT LIMESTONE, MEDIUM LIGHT GRAY (N6), HARD, STYLOLITES, FOSSILIFEROUS, MASSIVE, FRESH.	
							575.0	83			BOTTOM OF BORING AT 83.0 FT. BORING GROUTED TO SURFACE ON 2/6/86.	

RQD=ROCK QUALITY DESIGNATION FOR EACH RUN.
AP=AVERAGE LENGTH OF CORE PIECES.
LP=LONGEST PIECE OF CORE FROM EACH RUN.

ALL SOIL AND ROCK COLOR DESCRIPTIONS FROM THE ROCK COLOR CHART PRINTED BY THE GEOLOGICAL SOCIETY OF AMERICA.

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENNISON; P=PITCHER; O=OTHER

SITE	HOLE NO.
EAST OF BUILDING 428	G-2A

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	1 OF 3	G-3

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
NORTHWEST OF COAL STORAGE AREA	N101,195.3 W50,948.6	90	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
2/7/86	2/11/86	TONY CALTRY BROTCKE ENGINEERING	CME-55 ATV	6 1/4" 3"	54.6	33.6	88.2 FT

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
30.5/91	4	11	-	654.0	65.55 FT/588.45	54.6 FT/599.4

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 LBS/30 IN	NONE	LAWRENCE YOUNG

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS "N" PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							654.0	0				
				1ST 6"	2ND 6"	3RD 6"	653.5	0.5			0-0.5 FT GRAVEL, LIGHT GRAY (N7), LIMESTONE.	0-54.6 FT DRILLED WITH 6¼IN OD HOLLOW STEM AUGERS.
											0.5-4.0 FT CLAYEY SILT, BLACK (N1), SOFT, MOIST, ORGANIC DEBRIS.	
							650.0	4			4.0-42.0 FT CLAYEY SILT, MODERATE BROWN (5YR 4/4), MOIST, VERY STIFF, TRACE CHERT GRAVEL.	
SS 2"	18"	18"	17	4	6	11		5		1		
SS 2"	18"	18"	16	4	7	9		10		2		
SS 2"	18"	18"	22	5	9	13		15		3		
SS 2"	18"	18"	26	7	10	16		20		4		
SS 2"	18"	18"	33	14	15	18		25		5		DRIVING COBBLE.
SS 2"	18"	18"	28	7	13	15		30		6		
							619.0	35				

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENNISON; P=PITCHER; O=OTHER	SITE	HOLE NO.
	NORTHWEST OF COAL STORAGE AREA	G-3

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	2 of 3	G-3

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH / CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
SS 2"	18"	18"	23	1ST 6" 7	2ND 6" 10	3RD 6" 13	619.0	35	7		
SS 2"	18"	15"	39	15	18	21		40	8		
							612.0	42		42.0-54.6 FT SILT AND GRAVEL, PALE REDDISH BROWN (10YR 5/4) TO MODERATE REDDISH BROWN (10YR 6/6), MOIST, STIFF, SILT AND ANGULAR CHERT GRAVEL	BOREHOLE WAS RADIOLOGICALLY LOGGED BY EBERLINE ANALYTICAL CORPORATION PRIOR TO CORING.
SS 2"	18"	14"	88	23	48	40		45	9		
SS 2"	14"	13"	70+	14	20	50/2"		50	10		SAMPLER REFUSAL.
									11		BURLINGTON/ KEOKUK FM.
SS 2"	1.5"	0"	50+	50/1.5"	-	-	599.4	54.6			
NO CORE	8.4'	6.7'	80	23.1 25.0 26.3	5 10 15	4 9 7		55 – 60	RUN #1	54.6-63.0 FT LIMESTONE, DARK YELLOWISH ORANGE (10YR 6/6) TO LIGHT GRAY (N7), MEDIUM SOFT TO MEDIUM HARD, EXTREMELY WEATHERED, HORIZONTALLY FRACTURED, IRON STAINED, FRACTURES FILLED WITH SILT AND CLAY, PLANAR-ROUGH SURFACES, OCCASIONAL STYLOLITES AND THIN (0.1 TO 0.2 FT) CHERT LAYERS.	54.6-88.2 FT DRILLED WITH NO DIAMOND CORING USING WATER. RUN #1 RQD = 71% AP = 0.4 FT LP = 0.75 FT
NO CORE	8.5'	8.0'	94				591.0	63 – 65 – 70	RUN #2	63.0-80.5 FT LIMESTONE, LIGHT GRAY (N7), MEDIUM HARD, MODERATELY WEATHERED, WITH DARK YELLOWISH BROWN (10YR 4/2) HIGHLY TO MODERATELY WEATHERED, SOFT ZONES 0.1 TO 0.8 FT THICK; HORIZONTALLY FRACTURED.	2/11/86 RUN #2 RQD = 51% AP = 0.3 FT LP = 0.65 FT
NO CORE	6.7'	6.7'	100				579.0	75	RUN #3		RUN #3 RQD = 72% AP = 0.5 FT LP = 1.0

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER

SITE	HOLE NO.
NORTHWEST OF COAL STORAGE AREA	G-3

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	3 OF 3	G-3

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							579.0	75				
NO CORE	10.0	9.1'	91				573.5	80.5		RUN #4	80.5-88.2 FT LIMESTONE, MEDIUM LIGHT GRAY (N6), MEDIUM HARD, SLIGHTLY WEATHERED, HEALED HORIZONTAL FRACTURES FILLED WITH CALCITE, STYLOLITES.	RUN #4 RQD = 80% AP = 0.4 FT LP = 1.0 FT
							565.8	88.2			BOTTOM OF BORING AT 88.2. BORING GROUTED TO SURFACE ON 2/11/86.	45 FT. OF 4 INCH PVC CASING LOST IN THE HOLE. RQD=ROCK QUALITY DESIGNATION FOR EACH RUN. AP=AVERAGE LENGTH OF CORE PIECES. LP=LONGEST PIECE OF CORE FROM EACH RUN. ALL SOIL AND ROCK COLOR DESCRIPTIONS FROM THE ROCK COLOR CHART PRINTED BY THE GEOLOGICAL SOCIETY OF AMERICA.

Depth scale marks: 75, 80, 85

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER

SITE	HOLE NO.
NORTHWEST OF COAL STORAGE AREA	G-3

BECHTEL

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	1 of 3	G-4

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
NORTH OF ASH POND	N101,140.6 W51,295.6	90	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
2/11/86	2/13/86	TONY CALTRY BROTCKE ENGINEERING	CME-55 ATV	6 1/4"/3"	53.0	28.0	81.0 FT

CORE RECOVERY(FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
~26.2/94	3	10	-	644.0	56.0 FT/587.90	53.0 FT/591.0

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 LBS/30 IN	NONE	LAWRENCE YOUNG

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS % PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M. (1ST 6")	PRESSURE P.S.I. (2ND 6")	TIME IN MINUTES (3RD 6")	ELEVATION	DEPTH	SAMPLE
							644.0	0	
							642.0	2	
SS 2"	18"	16"	15	3	7	8		5	1
SS 2"	18"	18"	15	4	6	9		10	2
SS 2"	18"	18"	21	5	10	11		15	3
SS 2"	18"	19"	28	6	13	15		20	4
SS 2"	18"	24"	27	8	13	14		25	5
SS 2"	18"	24"	24	7	10	14		30	6
							609.3	34.7	
							609.0	35	

DESCRIPTION AND CLASSIFICATION

0-2.0 FT CLAYEY SILT, BLACK (N1), ORGANIC DEBRIS.

2.0-34.7 FT SILTY CLAY - CLAYEY SILT, MODERATE BROWN (5YR 3/4), STIFF TO VERY STIFF, MOIST, TRACE TO SOME ANGULAR TO SUBANGULAR CHERT GRAVEL, MEDIUM GRAY (N5) SILT LENSES.

NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.

0-53.0 FT DRILLED WITH 6¼IN OD HOLLOW STEM AUGERS.

SS=SPLIT SPOON ST=SHELBY TUBE D=DENISON P=PITCHER O=OTHER

SITE	HOLE NO.
NORTH OF ASH POND	G-4

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	2 OF 3	G-4

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS or PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M. / 1ST 6"	PRESSURE P.S.I. / 2ND 6"	TIME IN MINUTES / 3RD 6"	ELEVATION	DEPTH	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							609.0	35			
SS 2"	18"	15"	69	24	40	29			7	34.7-50.0 FT GRAVELLY, CLAYEY SILT, MODERATE REDDISH BROWN (10R 4/6), HARD, GRAVEL IS PRIMARILY VERY LIGHT GRAY (N8) ANGULAR CHERT.	
SS 2"	15"	15"	75+	11	25	50/3"		40	8		
SS 2"	18"	10"	31	14	17	14		45	9		BOREHOLE WAS RADIOLOGICALLY LOGGED BY EBERLINE ANALYTICAL CORPORATION PRIOR TO CORING.
SS 2"	18"	11"	48	20	26	22	594.0	50	10	50.0-53.0 FT LIMESTONE, VERY LIGHT GRAY (N8), SOFT, EXTREMELY WEATHERED, MIXED WITH MODERATE REDDISH BROWN (10R 4/6) CLAY & VERY LIGHT GRAY (N8) CHERT GRAVEL	BURLINGTON/ KEOKUK FM.
							591.0	53		53.0-71.1 FT LIMESTONE, DARK YELLOWISH ORANGE (10YR 6/6) TO LIGHT GRAY (N7), MODERATELY SOFT TO MODERATELY HARD, VUGS (1 TO 3 CM), HORIZONTALLY FRACTURED WITH CLAY AND SILT FILLING AND PLANAR-ROUGH SURFACE, 0.1 TO 0.8 FT THICK DARK YELLOWISH BROWN (10YR 4/2), SOFT, EXTREMELY WEATHERED LAYERS, 0.1 TO 0.5 FT THICK VERY LIGHT GRAY (N8) CHERT LAYERS AND NODULES.	53.0-81.0 FT DRILLED WITH NQ WIRE LINE DIAMOND CORING USING WATER. ▽ 2/13/86
NO CORE	8'	6.2'	78	17.2 19.4 21.6	5 10 15	9 10 13		55 60	RUN #1		RUN #1 RQD = 50% AP = 0.3 FT LP = 0.5 FT
NO CORE	10'	10'	100					65	RUN #2	62.9 FT FRACTURE ORIENTED 70° RELATIVE TO CORE AXIS, NO FILLING, PLANAR-SMOOTH SURFACE.	RUN #2 RQD = 75% AF = 0.4 FT LP = 1.4 FT
								70		70.5 FT LARGE STYLOLITE	
							572.9	71.1		71.1-81.0 FT LIMESTONE, MEDIUM LIGHT GRAY (N6), HARD, SLIGHTLY WEATHERED, 0.1 TO 0.5 FT CHERT LAYERS AND NODULES, STYLOLITES.	ALL BREAKS IN THIS ZONE APPEAR MECHANICAL AND ALONG STYLOLITES.
							569.0	75			

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER

SITE	HOLE NO.
NORTH OF ASH POND	G-4

BECHTEL

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	3 OF 3	G-4

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS OR PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							569.0	75				
NQ CORE	10'	10'	100					80		RUN #3		RUN #3 RQD = 70% AP = 0.4 FT LP = 1.2 FT
							563.0	81			BOTTOM OF BORING AT 81.0 FT. BORING GROUTED TO SURFACE ON 2/13/86.	ALL SOIL AND ROCK COLOR DESCRIPTIONS FROM THE ROCK COLOR CHART PRINTED BY THE GEOLOGICAL SOCIETY OF AMERICA. RQD=ROCK QUALITY DESIGNATION FOR EACH RUN AP=AVERAGE LENGTH OF CORE PIECES. LP=LONGEST PIECE OF CORE FROM EACH RUN.

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENNISON; P=PITCHER; O=OTHER

SITE	HOLE NO.
NORTH OF ASH POND	G-4

BECHTEL

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	1 of 2	G-5

SITE	COORDINATES		ANGLE FROM HORIZ.	BEARING
ADJACENT TO ASH DISCHARGE LINE	N100,650	W51,250	90	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
7/8/86	8/4/86	GEOTECHNOLOGY KURT JAEGER	CME-55	6"/3"	40.0	33.0	73.0'

CORE RECOVERY(FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
~30.3/92	3	8	-	635.9	38.0/598.0	40.0'/595.9

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 LBS/30 IN	NONE	A. ATKINSON

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	SAMPLE
							635.9	0	
6" HSA							634.9		
SS 2"	18"	12.5"	26	9	12	14		5	SS-1
6" HSA									
ST 3"	24"	22"					628.9	7	ST-1
SS 2"	18"	0	27	10	14	13			
HSA								10	
SS 2"	18"	3.5"	23	9	10	13			SS-2
6" HSA									
SS 2"	18"	18"	17	6	9	8		15	SS-3
6" HSA							618.9	17	
SS 2"	18"	21"	23	7	13	10		20	SS-4
6" HSA							613.9	22	
SS 2"	18"	18"	50	18	23	27		25	SS-5
6" HSA									
SS 2"	18"	16"	29	13	17	12		30	SS-6
6" HSA									
SS 2"	8"	11"	50/2"	43	50/2"	-			7
							600.9	35	

DESCRIPTION AND CLASSIFICATION

0 TO 1.0 FT ORGANIC DEBRIS, GRASS, LEAVES, ROOTS, WOOD FRAGMENTS.

1.0 TO 7.0 FT CLAY SILT/SILTY CLAY, MOTTLED ORANGE AND GRAY (10YR 5/4), VERY STIFF, MOIST, BLACK FRAGMENTS.

7.0 TO 17.0 FT SILTY CLAY, YELLOWISH BROWN (10YR 5.5/5) TO ORANGE (10YR 5/5) AND GRAY (5Y 5/1), VERY STIFF, MOIST, TRACE SAND.

17.0 TO 22.0 FT CLAYEY SILT, GRAYISH ORANGE (10YR 6/3), WITH ORANGE AND BLACK MOTTLING, VERY STIFF, MOIST.

22.0 TO 40.0 FT GRAVELLY CLAY, ORANGE (10YR5/4 TO 10YR 5/6) TO YELLOW (10YR 6/6) VERY STIFF TO HARD, MOIST, WITH ANGULAR WHITE (N9) TO DARK YELLOWISH ORANGE (10YR 6/6) CHERT.

NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.

0-38.0 FT DRILLED WITH 6IN OD HOLLOW STEM AUGERS USING CENTER PLUG.

0 TO 10.0 FT. BOREHOLE WAS RADIOLOGICALLY LOGGED BY EBERLINE ANALYTICAL CORPORATION.

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER

SITE	HOLE NO.
ADJACENT TO ASH DISCHARGE LINE	G-5

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	2 of 2	G-5

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	PERCENT CORE RECOVERY	SAMPLE
6" HSA				
6" TRICONE				
NXB CORE BARREL WITH DIAMOND BIT	3.0	3.0	100	RUN #1
	5.0	5.0	100	RUN #2
	4.7	4.7	100	RUN #3
	4.3	3.7	86	RUN #4
	1.0	0.0	0	5
	5.0	3.6	72	RUN #6
	5.0	4.8	96	RUN #7
	5.0	5.0	100	RUN #8

WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES
0	20	5
0	30	5
0	20	5
0.02	30	5
0.01	20	5

ELEVATION	DEPTH	DESCRIPTION AND CLASSIFICATION
600.9	35	
595.9	40	40.0 TO 67.5 FT LIMESTONE, YELLOW TO BEIGE, MODERATELY TO LOCALLY EXTREMELY WEATHERED, MODERATELY HARD, MODERATELY TO EXTREMELY FRACTURED, WHITE TO GRAY, VERY HARD LAYERS AND PATCHES OF CHERT. 40.0 TO 40.1 FT CLAY SEAM. 46.6 TO 47.0 FT CLAY SEAM.
	55	55.8 TO 58 FT QUARTZ FILLING.
		58.0 TO 67.5 FT BECOMING FRESHER WITH HIGHLY WEATHERED ZONES AND SOME STYLOLITES.
568.4		67.5 TO 73.0 FT LIMESTONE, BLUE-GRAY, FRESH, HARD, CRYSTALLINE, WITH OCASSIONAL LAYERS AND PATCHES OF WHITE AND GRAY CHERT.
562.9	73	BOTTOM OF BORING AT 73.0 FT. BORING GROUTED TO SURFACE ON

NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.

38.0 FT AUGER REFUSAL.

▽ 8/4/86

38.0 TO 40.0 FT DRILLED WITH 6-IN TRICONE ROLLER BIT AND WATER.

40.0 TO 73.0 FT CORED WITH NXB WIRELINE DIAMOND IMPREGNATED BIT USING WATER.

BURLINGTON/KEOKUK FM.

RUN	AP (FT)	LP (FT)	RQD (%)
1	0.1	0.4	21
2	0.2	0.5	[illegible]
3	0.2	0.7	
4	0.2	1.0	
6	0.2	0.8	54
7	0.2	0.8	63
8	0.3	0.8	72

RQD=ROCK QUALITY DESIGNATION FOR EACH RUN.
AP=AVERAGE LENGTH OF CORE PIECES.
LP=LONGEST PIECE OF CORE FROM EACH RUN.

ALL SOIL AND ROCK COLOR DESCRIPTIONS FROM THE ROCK COLOR CHART PRINTED BY THE GEOLOGICAL SOCIETY OF AMERICA, 1948.

SS=SPLIT SPOON ST=SHELBY TUBE, D=DENISON P=PITCHER O=OTHER

SITE	HOLE NO.
ADJACENT TO ASH DISCHARGE LINE	G-5

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	1 OF 2	G-6

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
SOUTH OF ASH POND	N100,450 W51,150	90	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
6/17/83	6/20/86	GEOTECHNOLOGY INC. KURT JAEGER/GEORGE MATTHEWS	CME-45/CME-750	6-1/4"/3"	23.5	43.5	67.0'

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
~ 29.0/71	4	6	-	639.7	10.77/628.99	23.5'/616.2

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 LBS/30 IN	NONE	LAWRENCE YOUNG

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS or PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	SAMPLE
							639.7	0	
SS 2"	18"	12"	14	4	7	7			1
SS 2"	18"	18"	18	3	8	10			2
ST 3"	2'	2'	PUSHED @ 700 PSI.						3
SS 2"	18"	18"	19	6	8	11			4
							623.7	16	
ST 3"	2'	0'	PUSHED @ 1000 PSI.						5
SS 2"	3"	3"	50+	50/3"					6
							616.2	23.5	
NXB	2.0'	2.0'	100						RUN #1
NXB WIRE LINE CORE	3.0'	1.0'	33						RUN #2
NXB WIRE LINE CORE	9.0'	1.3'	14						RUN #3
							604.7	35	

DESCRIPTION AND CLASSIFICATION

0 TO 16.0 FT SILTY CLAY, MODERATE BROWN (5YR 4/4), MOTTLED WITH MEDIUM LIGHT GRAY(N6) SILT LENSES, MOIST, STIFF TO VERY STIFF, TRACE TO SOME FINE GRAVEL (PRIMARILY IGNEOUS AND METAMORPHIC COMPOSITION), PYROLUSITE STRINGERS.

16.0 TO 23.5 FT GRAVELLY CLAY, DARK YELLOWISH ORANGE(10YR 6/6), MOIST, HARD WITH LIGHT GRAY(N7) ANGULAR CHERT GRAVEL.

23.5 TO 40.0 FT LIMESTONE, LIGHT BROWNISH GRAY (5YR 6/1), MEDIUM SOFT TO MEDIUM HARD, SEVERELY WEATHERED, WITH MODERATE BROWN(5YR 3/4)CLAY SEAMS, CHERT GRAVEL, SEAMS UP TO 1.5 FT IN THICKNESS, INTERBEDDED WITH SEMI-COMPETENT CHERT LENSES OR LAYERS.

NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.

0-23.5 FT DRILLED WITH 6¼IN OD HOLLOW STEM AUGERS USING CENTER PLUG.

0 TO 10.0 FT BOREHOLE WAS RADIOLOGICALLY LOGGED BY EBERLINE ANALYTICAL CORPORATION.

▽ 6/20/86 *

* MAY BE AFFECTED BY INCOMPLETE BREAKDOWN OF CLEAR MUD.

SHELBY TUBE STUCK IN HOLE. DROVE SPLIT SPOON SAMPLER INTO TUBE TO RECOVER.

23.5 FT AUGER REFUSAL
23.5 TO 25.0 FT USED TRICONE ROLLER BIT TO START CORE HOLE.

25.0 TO 67.0 FT CORED WITH NXB WIRELINE DIAMOND IMPREGNATED BIT USING WATER AND CLEAR MUD.

RUN	AP (FT)	LP (FT)	RQD (%)
1		0.7	30
2	0.1	0.4	33

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER

SITE	HOLE NO.
SOUTH OF ASH POND	G-6

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	2 of 2	G-6

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS or PERCENT CORE RECOVERY	LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	SAMPLE	DESCRIPTION AND CLASSIFICATION
							604.7	35		
NXB WIRE-LINE CORE	9.0'	8.2'	91				599.7	40	RUN #4	40.0 TO 54.0 FT <u>LIMESTONE</u>, DARK YELLOWISH ORANGE (10YR 6/6), MEDIUM HARD, MODERATELY WEATHERED, VUGGY, OCCASIONAL STYLOLITES, HORIZONTAL FRACTURES WITH ROUGH - PLANAR IRON STAINED APERATURES.
NXB WIRE-LINE CORE	5.0'	3.0'	60					50	RUN #5	49.0 TO 54.0 FT SEVERELY WEATHERED ZONE, BROKEN, IRON STAINED.
NXB WIRE-LINE CORE	4.0'	3.7'	93				585.7	54	RUN #6	54.0 TO 63.2 FT <u>LIMESTONE</u>, BROWNISH GRAY (5YR 4/1), HARD, MODERATELY WEATHERED, NO APPARENT FRACTURES, OCCASIONAL THIN SHALE INTERBEDS.
NXB WIRE-LINE CORE	7.0'	8.0'	114					60	RUN #7	
							576.5	63.2		63.2 TO 67.0 FT <u>LIMESTONE</u>, MEDIUM GRAY (N5), HARD, SLIGHTLY WEATHERED, STYLOLYTIC.
NXB	2.0	1.8	90					65	RUN #8	
							572.7	67		BOTTOM OF BORING AT 67.0 FT. BORING GROUTED TO SURFACE ON 6/20/86.

NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.

RUN	AP (FT)	LP (FT)	RQD (%)
3	0.2	0.6	6
4	0.3	0.6	32
5	0.1	0.3	44
6	0.3	0.8	73
7	0.4	1.2	67
8	0.3	0.8	54

ADDED 4 GALLONS OF BLEACH TO BREAK DOWN CLEAR MUD. HOLE CAVED AT 26.0 FT WHEN MUD BROKE DOW NO PACKER TES. WERE PERFORMED.

RQD=ROCK QUALITY DESIGNATION FOR EACH RUN.
AP=AVERAGE LENGTH OF CORE PIECES.
LP=LONGEST PIECE OF CORE FROM EACH RUN.

ALL SOIL AND ROCK COLOR DESCRIPTIONS FROM THE <u>ROCK COLOR CHART</u> PRINTED BY THE GEOLOGICAL SOCIETY OF AMERICA, 1948.

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER

SITE	HOLE NO.
SOUTH OF ASH POND	G-6

BECHTEL

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	1 of 2	G-7

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
NORTH OF COAL PILE	N101,200 W50,450	90	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
6/17/83	6/18/86	GEOTECHNOLOGY INC. KURT JAEGER/GEORGE MATTHEWS	CME-45/CME-750	6-1/4"/3"	18.5	45.5	64.0'

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
24.7/63	4	3	-	633.3	34.20'/599.10	18.5'/614.8

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 LBS/30 IN	NONE	LAWRENCE YOUNG

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH OF CORE RUN	SAMPLE RECOVERY/ CORE RECOVERY	SAMPLE BLOWS or PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	SAMPLE
							633.3	0	
SS 2"	18"	13"	13	3	5	8		5	1
SS 2"	18"	15"	20	5	8	12		10	2
							621.8	11.5	
SS 2"	11"	9"	50+	32	50/5"			15	3
							614.8	18.5	
NXB	2.0'	1.9'	95					20	RUN #1
								25	
NXB WIRE LINE CORE	3.0'	1.1'	91	10.6	5	5			RUN #2
				12.2	10	4		30	
NXB WIRE LINE CORE	7.0'	1.3'	19						RUN #3
							598.3	35	

DESCRIPTION AND CLASSIFICATION

0 TO 11.5 FT SILTY CLAY, MODERATE BROWN(5YR 4/4), MOIST, STIFF TO VERY STIFF, TRACE TO SOME SUBROUNDED TO ROUNDED FINE GRAVEL (PRIMARILY IGNEOUS AND METAMORPHIC ORIGIN), MOTTLED WITH LIGHT GRAY(N6) SILT LENSES, PYROLUSITE STRINGERS.

11.5 TO 18.5 FT GRAVELLY CLAY, DARK YELLOWISH ORANGE(10YR 6/6), MOIST, HARD, WITH WEATHERED ANGULAR CHERT GRAVEL AND COBBLES.

18.5 TO 37.0 FT LIMESTONE, DARK YELLOWISH ORANGE(10YR 6/6), MODERATELY HARD, SEVERELY WEATHERED, WITH SEAMS OF MODERATE REDDISH BROWN(10R 4/6) CLAY AND CHERT GRAVEL, SEMI-COMPETENT CHERT LAYERS OR NODULES.

21.0 TO 26.0 FT CLAY FILLED CAVITY WITH COAL DUST OR FLY-ASH MIXED WITH CLAY, AND ANGULAR CHERT GRAVEL.

NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.

0-18.5 FT DRILLED WITH 6 1/4IN OD HOLLOW STEM AUGERS USING CENTER PLUG.

0 TO 10.0 FT BORE HOLE WAS RADIOLOGICALLY LOGGED BY EBERLINE ANALYTICAL CORPORATION.

18.5 TO 19.0 FT DRILLED WITH 2-7/8 INCH TRICONE ROLLER BIT AND FRESH WATER TO START COREHOLE.
19.0 TO 21.0 FT CORED WITH NXB WIRELINE DIAMOND IMPREGNATED BIT USING CLEAR WATER.
21.0 TO 27.0 FT DRILLED WITH TRICONE ROLLER BIT USING CLEAR MUD.
27.0 TO 64.0 FT CORED WITH NXB WIRELINE DIAMOND IMPREGNATED BIT USING WATER AND CLEAR MUD.

RUN	AP (FT)	LP (FT)	RQD (%)
1	0.3	0.2	0
2	0.3	0.2	0
3	0.2	0.2	0

▽ 6/18/86

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER

SITE	HOLE NO.
NORTH OF COAL PILE	G-7

BECHTEL

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	2 of 2	G-7

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS 'N' / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							598.3	35				
NXB WIRE LINE CORE	8.0'	5.7'	71				596.3	37		RUN #4	37.0 TO 55.6 FT LIMESTONE, DARK YELLOWISH ORANGE(10YR 6/6) TO MODERATE YELLOWISH BROWN(10YR 5/4), MODERATELY HARD, MODERATELY TO SLIGHTLY WEATHERED, VUGGY, STYLOLITIC, THIN (UP TO 0.3 FT) CHERT LENSES, HORIZONTALLY FRACTURED WITH SMOOTH-PLANAR IRON STAINED APERATURES.	RUN #4 RQD = 44% AP = 0.3 FT LP = 0.5 FT
NXB WIRE LINE CORE	9.0'	7.6'	84					45–50		RUN #5		RUN #5 RQD = 21% AP = 0.3 FT LP = 0.7 FT
NXB WIRE LINE CORE	10.0'	9.0'	90				577.7	55.6		RUN #6	55.6 TO 64.0 FT LIMESTONE, MEDIUM GRAY (N5), HARD, SLIGHTLY WEATHERED TO FRESH MEDIUM LIGHT GRAY(N6) CHERT LENSES, INTERBEDS OF DARK GRAY(N3) TO DARK GREENISH GRAY(5GY 4/1) SHALE, STYLOLITIC.	RUN #6 RQD = 53% AP = 0.3 FT LP = 1.5 FT ADDED FOUR BOTTLES OF BLEACH TO HOLE TO BREAK DOWN CLEAR MUD.
							569.3	64			BOTTOM OF BORING AT 64.0 FT. BORING GROUTED TO SURFACE ON 6/18/86. RQD=ROCK QUALITY DESIGNATION FOR EACH RUN. AP=AVERAGE LENGTH OF CORE PIECES. LP=LONGEST PIECE OF CORE FROM EACH RUN.	ALL SOIL AND ROCK COLOR DESCRIPTIONS FROM THE ROCK COLOR CHART PRINTED BY THE GEOLOGICAL SOCIETY OF AMERICA, 1948.

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER

SITE	HOLE NO.
NORTH OF COAL PILE	G-7

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	1 of 3	G-8

SITE	COORDINATES		ANGLE FROM HORIZ.	BEARING
EAST OF BLDG. 407	N100,450	W49,900	90	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
6/16/86	6/18/86	GEOTECHNOLOGY INC. KURT JAEGER/GEORGE MATTHEWS	CME-45/CME-750	6-1/4"/3"	30.0	45.0	75.0'

CORE RECOVERY(FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
~41.3/92	5	8	-	655.3	52.2'/603.1B	30.0'/625.3

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 LBS/30 IN	NONE	LAWRENCE YOUNG

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M. / 1ST 6"	PRESSURE P.S.I. / 2ND 6"	TIME IN MINUTES / 3RD 6"	ELEVATION	DEPTH	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							655.3	0			
							654.8	0.5		0 TO 0.5 FT GRAVEL, MEDIUM GRAY(N5), LIMESTONE, TRACE ORGANIC DEBRIS, ROADBED.	0-30.0 FT DRILLED WITH 6¼IN OD HOLLOW STEM AUGERS USING CENTER PLUG.
										0.5 TO 15.0 FT SILTY CLAY, DARK GREENISH GRAY(5GY 4/1) TO MODERATE YELLOWISH BROWN(10YR 5/4), MOIST, MEDIUM STIFF, TO STIFF, MOTTLED WITH MEDIUM GRAY(N5) SILT LENSES, OXIDIZED ZONES NEAR BOTTOM OF UNIT.	
SS 2"	18"	5"	6	3	3	3			1		
								5			0 TO 10.0 FT BOREHOLE WAS RADIOLOGICALLY LOGGED BY EBERLINE ANALYTICAL CORPORATION.
SS 2"	18"	13"	13	2	5	8			2		
								10			
ST 3"	2.0'	2.0'	PUSHED @ 700 PSI						3		
SS 2"	18"	19"	12	4	5	7			4		
							640.3	15		15.0 TO 26.0 FT SILTY CLAY, LIGHT BROWN (5YR 5/6), MOIST, VERY STIFF, SOME FINE GRAVEL, PYROLUSITE STRINGERS.	
SS 2"	18"	21"	17	4	6	11			5		
								20			
ST 3"	2.0'	2.0'	PUSHED @ 700 PSI						6		
SS 2"	18"	24"	18	6	7	11			7		
								25			
							629.3	26		26.0 TO 30.0 FT GRAVELLY CLAY, LIGHT BROWN(5YR 6/6) TO DARK YELLOWISH ORANGE (10YR 6/6), MOIST, HARD, VERY LIGHT GRAY (N8), MODERATELY WEATHERED, ANGULAR CHERT GRAVEL, TRACE TO SOME FINE-GRAINED SAND.	AUGER REFUSAL AT 30.0 FT.
SS 2"	11-1/2"	9"	50+	5	50/ 5-1/2"				8		
							625.3	30		30.0 TO 34.3 FT LIMESTONE, DARK YELLOWISH ORANGE(10YR 4/6), MODERATELY SOFT, SEVERELY WEATHERED, WITH MODERATE BROWN (5YR 3/4), CLAY SEAMS WITH CHERT GRAVEL AND SEMI-COMPETENT CHERT LAYERS.	30.0 TO 75.0 FT. DRILLED WITH NXB DIAMOND IMPREGNATED CORE BIT AND FRESH WATER.
NXB WIRE LINE CORE	10.0	9.0	90	12.1 13.2 ↓ 15.5	5 10 ↓ 5	9 8 ↓ 6			RUN #1		RUN #1 RQD = 30% AP = 0.4 FT LP = 0.5 FT
							621.0 620.3	34.3 35			

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER

SITE	HOLE NO.
EAST OF BLDG. 407	G-8

BECHTEL

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	2 OF 3	G-8

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS / % / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
				16.0	10	8	620.3	35		34.3 68.7 FT LIMESTONE, BROWNISH GRAY (5YR 4/1) TO DARK YELLOWISH ORANGE (10YR 4/6), MODERATELY HARD, MODERATELY TO SLIGHTLY WEATHERED, STYLOLITIC, VUGGY CHERT LAYERS OR NODULES, HOIZONTALLY FRACTURED WITH IRON STAINED AND CLAY FILLED ROUGH-PLANAR APERATURES.	
NXB WIRE LINE CORE	10.0'	7.7'	77				613.3	42	RUN #2	42.0 TO 44.0 FT CLAY FILLED CAVITY.	RUN #2 RQD = 52% AP = 0.3 FT LP = 0.6 FT
							611.3	44			
NXB WIRE LINE CORE	8.0'	7.6'	95						RUN #3	52.6 TO 58.0 FT BROKEN ZONE.	▽ 6/18/86 RUN #3 RQD = 33% AP = 0.3 FT LP = 0.5 FT
NXB WIRE LINE CORE	7.0'	7.0'	100						RUN #4		RUN #4 RQD = 55% AP = 0.3 FT LP = 0.7 FT
NXB WIRE LINE CORE	10.0'	10.0'	100				586.6	68.7	RUN #5	68.7 TO 75.0 FT LIMESTONE, BROWNISH GRAY(5YR 4/1) TO MEDIUM GRAY(N5), HARD SLIGHTLY WEATHERED, CHERT NODULES WITH VUGS IN CHERT.	RUN #5 RQD = 39% AP = 0.3 FT LP = 0.7 FT
							580.3	75			

SS=SPLIT SPOON, ST=SHELBY TUBE; D=DENNISON, P=PITCHER, O=OTHER	SITE	HOLE NO.
	EAST OF BLDG. 407	G-8

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	3 of 3	G-8

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS or PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							580.3	75			BOTTOM OF BORING AT 75.0 FT. BORING GROUTED TO SURFACE ON 6/18/86.	RQD=ROCK QUALITY DESIGNATION FOR EACH RUN. AP=AVERAGE LENGTH OF CORE PIECES. LP=LONGEST PIECE OF CORE FROM EACH RUN. ALL SOIL AND ROCK COLOR DESCRIPTIONS FROM THE ROCK COLOR CHART PRINTED BY THE GEOLOGICAL SOCIETY OF AMERICA, 1948.

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER

SITE: EAST OF BLDG. 407

HOLE NO. G-8

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	1 of 3	G-9

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
ADJACENT TO BLDG. 410	N100,065 W49,905	90	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
6/12/86	6/16/86	GEOTECHNOLOGY INC. KURT JAEGER	CME-45	6-1/4"/3"	37.5	38.5	76.0'

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
~34.5/91	4	9	-	656.0	49.47'/606.53	37.5'/618.5

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 LBS/30 IN	NONE	LAWRENCE YOUNG

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS OR PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M. 1ST 6"	PRESSURE P.S.I. 2ND 6"	TIME IN MINUTES 3RD 6"	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							656.0	0			0 TO 0.5 FT SILTY CLAY, GRAYISH BLACK (N2), MOIST, TRACE CHERT GRAVEL.	0-37.5 FT DRILLED WITH 6¼ IN OD HOLLOW STEM AUGERS USING CENTER PLUG.
											0.5 TO 26.0 FT SILTY CLAY, MEDIUM GRAY (N5), MOIST, STIFF TO VERY STIFF, OXIDIZED ZONES.	
SS 2"	18"	12"	17	3	8	9		5		1		
ST	2'	2'	PUSHED 500 PSI	-	-	-				2		0 TO 10.0 FT BOREHOLE WAS RADIOLOGICALLY LOGGED BY EBERLINE ANALYTICAL CORPORATION.
SS 2"	18"	17"	15	4	7	8		10		3		
SS 2"	18"	19"	10	2	4	6		15		4		
							640.0	16			16.0 TO 26.0 FT SILTY CLAY, DARK YELLOWISH ORANGE (10YR 6/6) TO LIGHT BROWN (5YR 5/6), MOIST, VERY STIFF, SOME SUB-ROUNDED FINE GRAVEL (IGNEOUS AND METAMORPHIC COMPOSITION), PYROLUSITE AND IRON OXIDE STRINGERS, MOTTLED WITH MEDIUM GRAY (N5) SILT LENSES.	
ST	2'	2'	PUSHED 500 PSI	-	-	-				5		
SS 2"	18"	18"	18	4	8	10		20		6		
SS 2"	18"		17	4	7	10		25		7		
							630.0	26			26.0 TO 37.5 FT GRAVELLY CLAY, MODERATE REDDISH BROWN (10R 4/6), MOIST, VERY STIFF TO HARD, LIGHT GRAY (N7) ANGULAR CHERT GRAVEL, TRACE FINE-GRAINED SAND.	
SS 2"	11"		74+	24	50/5"			30		8		
SS 2"	18"	3"	18	12	10	8	621.0	35		9		37.5 FT PERFORM INTERFACE PERMEABILITY TEST.

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER	SITE	HOLE NO.
	ADJACENT TO BLDG. 410	G-9

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	2 of 3	G-9

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS % PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							621.0	35			37.5 TO 38.0 FT DRILLED WITH 2-7/8 INCH ROLLER BIT USING WATER.
							618.5	37.5		37.5 TO 65.0 FT LIMESTONE, DARK YELLOWISH ORANGE(10YR 5/4), MODERATELY WEATHERED, MODERATELY HARD, FOSSILIFEROUS ZONES, VUGGY, HORIZONTALLY FRACTURED, CHERT LENSES UP TO 0.3 FT THICK.	38.0 TO 76.0 FT DRILLED WITH NXB WIRELINE DIAMOND CORE BIT USING WATER AND CLEAR MUD.
NXB WIRELINE	5.5'	5.2'	94					40 41.5 41.9	RUN #1	41.5 TO 41.9 FT CAVITY, FILLED WITH MODERATE YELLOWISH BROWN(10YR 5/4) CLAY AND ANGULAR CHERT GRAVEL, SMOOTH-PLANAR APERATURE.	
NXB WIRELINE	7.5'	5.2'	69					45 45.2 47.2 50	RUN #2	45.2 TO 47.2 FT CAVITY, FILLED WITH MODERATE YELLOWISH BROWN(10YR 5/4) CLAY AND ANGULAR CHERT GRAVEL, ROUGH-PLANAR APERATURE.	▽ 6/16/86
NXB WIRELINE	6.5'	5.8'	89					55	RUN #3	51.8 FT IRON STAINED VUG, APPROXIMATELY 3 CM WIDE.	
NXB	2.5'	2.1'	84					60	RUN #4	56.7 FT IRON STAINED VUG, APPROXIMATELY 2 CM WIDE.	
NXB WIRELINE	6.0'	6.2'	100				591.0	65	RUN #5		
NXB WIRELINE	10.0'	10.0'	100	0.004 0.18	16 30	20 15	581.0	70 75	RUN #6	65.0 TO 76.0 FT LIMESTONE, BROWNISH GRAY(5YR 4/1) TO LIGHT GRAY(N7), HARD, SLIGHTLY WEATHERED TO FRESH, STYLOLITIC, MASSIVE, CHERT LENSES (UP TO 0.2 FT THICK). 66.0 TO 71.6 FT VUGGY ZONE, VUGS PRIMARILY ASSOCIATED WITH CHERT LENSES.	

RUN	AP (FT)	LP (FT)	RQD (%)
1	0.3	1.1	50
2	0.2	0.8	34
3	0.3	1.4	36
4	0.2	0.5	44
5	0.4	0.9	74
6	0.5	1.6	92

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER

SITE: ADJACENT TO BLDG. 410

HOLE NO. G-9

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	3 OF 3	G-9

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS % PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							581.0	75				
							580.0	76				
											BOTTOM OF BORING AT 76.0 FT. BORING GROUTED TO SURFACE ON 6/16/86.	ADDED 4 BOTTLES OF BLEACH TO BREAK DOWN CLEAR MUD. RQD=ROCK QUALITY DESIGNATION FOR EACH RUN. AP=AVERAGE LENGTH OF CORE PIECES LP=LONGEST PIECE OF CORE FROM EACH RUN. ALL SOIL AND ROCK COLOR DESCRIPTIONS FROM THE ROCK COLOR CHART PRINTED BY THE GEOLOGICAL SOCIETY OF AMERICA, 1948.

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENNISON; P=PITCHER; O=OTHER

SITE	HOLE NO.
ADJACENT TO BLDG. 410	G-9

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	1 of 2	G-13

SITE	COORDINATES		ANGLE FROM HORIZ.	BEARING
WEST OF BLDG. 301	N99,521	W50,517	90	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
6/10/86	6/12/86	GEOTECHNOLOGY INC. KURT JAEGER	CME-45	6-1/4"/3"	28.5	42.5	71.0'

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
~30.8/72	4	5	-	654.7	31.08'/623.62	28.5'/626.2

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 LBS/30 IN	NONE	LAWRENCE YOUNG

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS PER 6" / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN GPM / 1ST 6"	PRESSURE P.S.I. / 2ND 6"	TIME IN MINUTES / 3RD 6"	ELEVATION	DEPTH	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							654.7	0		0 TO 17.0 FT SILTY CLAY, BROWNISH GRAY (5YR 4/1) TO MEDIUM GRAY (N5), MOIST, MEDIUM STIFF TO STIFF, OXIDIZED ZONES.	0-28.5 FT DRILLED WITH 6¼IN OD HOLLOW STEM AUGERS USING CENTER PLUG.
SS 2"	18"	10"	9	4	3	6		5	1		0 TO 10.0 FT BOREHOLE WAS RADIOLOGICALLY LOGGED BY EBERLINE ANALYTICAL CORPORATION.
SS 2"	18"	18"	14	4	5	9		10	2		
SS 2"	18"	20"	13	3	6	7		15	3		
							637.7	17		17.0 TO 22.0 FT SILTY CLAY, MEDIUM GRAY (N5), MOIST, STIFF, TRACE TO SOME SUBROUNDED FINE GRAVEL, TRACE VERY FINE-GRAINED SAND, OXIDIZED ZONES, PYROLUSITE STRINGERS.	28.5 FT AUGER REFUSAL. 28.5 TO 71.0 FT DRILLED WITH NXB WIRELINE DIAMOND IMPREGNATED CORE BIT USING WATER AND CLEAR MUD.
SS 2"	18"	21"	16	4	8	8		20	4		
							632.7	22		22.0 TO 28.5 FT GRAVELLY CLAY, DARK YELLOWISH ORANGE (10YR 6/6), MOIST, HARD, ANGULAR CHERT GRAVEL, PYROLUSITE LENSES, TRACE VERY FINE-GRAINED SAND.	31.0 FT COMPLETE WATER LOSS.
SS 2"	18"	18"	35	5	15	20		25	5		BURLINGTON/KEOKUK FM.
NXB WIRE LINE CORE	7.0	3.8	54	14.9 16.5 18.7 16.3	5 10 20 10	15 6 6 5	626.2	28.5 30	RUN #1	28.5 TO 62.8 FT LIMESTONE, DARK YELLOWISH ORANGE (10YR 6/6) TO MODERATE YELLOWISH BROWN (10YR 5/4), MODERATELY HARD, MODERATELY WEATHERED, HORIZONTAL CLAY AND SAND FILLED FRACTURES WITH SMOOTH-PLANAR APERATURES, CHERT LENSES UP TO 0.3 FT THICK, VUGGY, OCCASIONAL STYLOLITES.	▽ 6/12/86 RUN #1 RQD = 68% AP = 0.3 FT LP = 0.7 FT
							619.7	35			

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER	SITE	HOLE NO.
	WEST OF BLDG. 301	G-13

GEOLOGIC DRILL LOG

PROJECT: FUSRAP - WELDON SPRING SITE | JOB NO.: 14501-201 | SHEET NO.: 2 of 2 | HOLE NO.: G-13

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS OR PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	SAMPLE
NXB WIRE LINE CORE	5.0'	1.8'	36				RUN #2
NXB WIRE LINE CORE	10.0	6.2'	62				RUN #3
NXB WIRE LINE CORE	4.5'	4.2'	93				RUN #4
NXB WIRE LINE CORE	2.0'	1.8'	90				RUN #5
NXB WIRE LINE CORE	9.0'	8.0'	89				RUN #6
NXB WIRE LINE CORE	5.0'	5.0'	100				RUN #7

ELEVATION	DEPTH	DESCRIPTION AND CLASSIFICATION
608.7	35	29.8 TO 31.0 FT CAVITY FILLED WITH MODERATE BROWN(5YR 3/4) CLAY AND ANGULAR CHERT GRAVEL, APERATURE ORIENTED 70° RELATIVE TO CORE AXIS.
	40	40.8 TO 41.3 FT HORIZONTAL FRACTURE FILLED WITH MODERATE BROWN(5YR 3/4) MEDIUM GRAINED SAND AND TRACE OF ANGULAR CHERT GRAVEL.
		44.0 TO 47.0 FT CAVITY FILLED WITH MODERATE BROWN(5YR 3/4) CLAY AND SOME ANGULAR CHERT GRAVEL.
591.9	62.8	62.8 TO 71.0 FT LIMESTONE, BROWNISH GRAY(5YR 4/1), MODERATELY HARD, SLIGHTLY WEATHERED, MASSIVE CHERT LENSES UP TO 0.2 FT THICK, SMALL VUGS (2 MM±) IN CHERT LENSES, NO APPARENT FRACTURES.
583.7	71	BOTTOM OF BORING AT 71.0 FT. BORING GROUTED TO SURFACE ON 6/12/86.

NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.

RUN	AP (FT)	LP (FT)	RQD (%)
2	0.4	0.4	45
3	0.3	0.6	42
4	0.2	0.5	[illegible]
5	0.2	0.4	[illegible]
6	0.5	1.0	75
7	0.6	2.4	70

ADDED 4 BOTTLES OF BLEACH TO BREAK DOWN CLEAR MUD.

RQD=ROCK QUALITY DESIGNATION FOR EACH RUN.

AP=AVERAGE LENGTH OF CORE PIECES.

LP=LONGEST PIECE OF CORE FROM EACH RUN.

ALL SOIL AND ROCK COLOR DESCRIPTIONS FROM THE ROCK COLOR CHART PRINTED BY THE GEOLOGICAL SOCIETY OF AMERICA 1948.

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENNISON; P=PITCHER; O=OTHER

SITE: WEST OF BLDG. 301 | HOLE NO.: G-13

BECHTEL

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	1 OF 3	G-14

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
SOUTH OF BLDG. 417	N99,199 W49,935	90	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
6/6/86	6/10/86	GEOTECHNOLOGY INC. KURT JAEGER	CME-45	6-1/4"/3"	37.5	38.9	76.4'

CORE RECOVERY(FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
~ 35.6/92	5	8	-	655.8	4.40'/614.4	37.5'/618.3

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 LBS/30 IN	NONE	LAWRENCE YOUNG

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS % PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M. (1ST 6")	PRESSURE P.S.I. (2ND 6")	TIME IN MINUTES (3RD 6")	ELEVATION	DEPTH	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							655.8	0			
							655.3	0.5		0 TO 0.5 FT GRAVEL, CRUSHED LIMESTONE, WITH FLYASH MATRIX, ROAD BED.	0-37.5 FT DRILLED WITH 6¼IN OD HOLLOW STEM AUGERS USING CENTER PLUG.
										0.5 TO 17.0 FT SILTY CLAY, DARK YELLOWISH ORANGE(10YR 6/6), MOIST, STIFF TO VERY STIFF, MOTTLED WITH MEDIUM GRAY (N6) SILT LENSES, IRON STAINED NODULES.	
SS 2"	18"	12"	15	7	8	7			1		
								5			0 TO 10.0 FT BOREHOLE WAS RADIOLOGICALLY LOGGED BY EBERLINE ANALYTICAL CORPORATION.
SS 2"	18"	17"	9	2	4	5			2		
								10			
SS 2"	18"	16"	19	3	7	12			3		
								15			
							638.8	17		17.0 TO 27.5 FT SILTY CLAY, DARK YELLOWISH ORANGE(10YR 6/6), MOIST, VERY STIFF, SOME GRAVEL, TRACE FINE-GRAINED SAND, PYROLUSITE STRINGERS.	
SS 2"	18"	21"	26	7	12	14			4		
								20			
SS 2"	18"	23"	29	14	15	14			5		
								25			
							628.3	27.5		27.5 TO 37.5 FT GRAVELLY CLAY, VERY LIGHT GRAY(N8) TO DARK YELLOWISH ORANGE (10YR 6/6), MOIST, HARD, WITH MODERATELY WEATHERED CHERT GRAVEL.	
SS 2"	18"	0"	56	40	38	18			6		
								30			
SS 2"	18"	7"	47	22	24	23			7		
SS 2"	18"	11"	32	3	14	18	620.8	35	8		

SS=SPLIT SPOON ST=SHELBY TUBE, D=DENISON P=PITCHER O=OTHER	SITE	HOLE NO.
	SOUTH OF BLDG. 417 ON PERIMETER ROAD	G-14

BECHTEL

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	2 of 3	G-14

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	SAMPLE	DESCRIPTION AND CLASSIFICATION
							620.8	35		
NXB	0.4	0.1	25				618.3	37.5	1	37.5 TO 57.2 FT LIMESTONE, DARK YELLOWISH ORANGE(10YR 6/4), SEVERELY TO MODERATELY WEATHERED, MODERATELY HARD TO HARD, CHERT LENSES UP TO 0.3 FT THICK, VUGS UP TO 3 CM WIDE, HORIZONTALLY FRACTURED WITH ROUGH PLANAR APERATURES AND IRON STAINING AND CLAY FILLING. 38.3 TO 38.8 FT HORIZONTAL FRACTURE, ROUGH PLANAR APERATURE, FILLED WITH MEDIUM LIGHT GRAY(N6) CLAY.
NXB	2.1'	1.8'	86					40	RUN #2	
NXB	5.0'	4.6'	92					45	RUN #3	
NXB	9.0'	7.7'	86					50	RUN #4	
NXB	0.7'	0.7'	100					55	RUN #5	
NXB	1.7'	0.7'	41						RUN #6	
NXB	10.1'	10.1'	100				598.6	57.2	RUN #7	57.2 TO 69.8 FT LIMESTONE, BROWNISH GRAY(5YR 4/1), HARD, SLIGHTLY WEATHERED, INTERBEDDED WITH GRAYISH BLACK(N2) TO MEDIUM DARK GRAY (N4) SHALE.
								60		
								65		
NXB	9.9'	9.9'	100	0 0 0 0 0	10 20 30 20 10	10 10 10 5 5	586.0	69.8	RUN #8	69.8 TO 76.4 FT LIMESTONE, LIGHT GRAY (N7), HARD, SLIGHTLY WEATHERED, MASSIVE, STYLOLITIC, CHERT NODULES, VUGGY ZONES, IN CHERT NODULES.
								70		
							580.8	75		

NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.

37.5 TO 76.4 FT DRILLED WITH NXB WIRELINE CORE BIT USING FRESH WATER.

BURLINGTON/KEOKUK FM.

▽ 6/9/86

37.9 FT COMPLETE WATER LOSS.

RUN	AP (FT)	LP (FT)	RQD (%)
1	0.1	0.1	0
2	0.2	0.5	27
3	0.3	0.6	58
4	0.4	1.3	86
5	0.2	0.3	0
6	0.1	0.2	0
7	0.4	0.8	54
8	0.6	2.0	70

SS=SPLIT SPOON ST=SHELBY TUBE, D=DENISON P=PITCHER O=OTHER

SITE	HOLE NO.
SOUTH OF BLDG. 417 ON PERIMETER ROAD	G-14

BECHTEL

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	3 of 3	G-14

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS or PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							580.8	75				
							579.4	76.4				
											BOTTOM OF BORING AT 76.4 FT. BORING GROUTED TO SURFACE ON 6/10/86.	SINGLE BX PACKER LOST IN HOLE AND GROUTED IN. RQD=ROCK QUALITY DESIGNATION FOR EACH RUN. AP=AVERAGE LENGTH OF CORE PIECES. LP=LONGEST PIECE OF CORE FROM EACH RUN. ALL SOIL AND ROCK COLOR DESCRIPTIONS FROM THE ROCK COLOR CHART PRINTED BY THE GEOLOGICAL SOCIETY OF AMERICA, 1948.

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENNISON; P=PITCHER; O=OTHER

SITE: SOUTH OF BLDG. 417 ON PERIMETER ROAD

HOLE NO. G-14

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	1 OF 3	G-15

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
EAST OF RAFFINATE PIT NO. 2	N98,924 W50,447	90	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
6/5/86	6/12/86	GEOTECHNOLOGY INC. KURT JAEGER	CME-45	6-1/4"/3"	41.0	34.5	75.5'

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
29.3/87	4	8	-	658.0	18.10'/639.9	41.0'/617.0

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 LBS/30 IN	NONE	LAWRENCE YOUNG

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M. / 1ST 6"	PRESSURE P.S.I / 2ND 6"	TIME IN MINUTES / 3RD 6"	ELEVATION	DEPTH	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							658.0	0		0 TO 8.0 FT SILTY CLAY, BROWNISH BLACK (5YR 2/1), MOIST, STIFF, ORGANIC DEBRIS, SOME LIMESTONE GRAVEL. (FILL)	0-41.0 FT DRILLED WITH 6-1/4" OD HOLLOW STEM AUGERS USING CENTER PLUG.
SS 2"	18"	10"	12	4	5	7		5	1		
							650.0	8		8.0 TO 8.5 FT SILTY CLAY, BLACK(N1), ORGANIC DEBRIS, TOPSOIL.	0 TO 10.0 FT BOREHOLE WAS RADIOLOGICALLY LOGGED BY EBERLINE ANALYTICAL CORPORATION.
SS 2"	18"	11"	9	2	3	6	649.5	8.5	2	8.5 TO 17.0 FT SILTY CLAY, BROWNISH GRAY(5YR 4/1) TO MODERATE YELLOWISH BROWN(5YR 5/4), MOIST, MEDIUM STIFF, LENSES OF LIGHT GRAY(N7) SILT.	
SS 2"	18"	18"	9	3	4	5		10 / 15	3		
							641.0	17		17.0 TO 31.5 FT SILTY CLAY, MODERATE YELLOWISH BROWN(10YR 5/4), MOIST, STIFF TO VERY STIFF, TRACE TO SOME CHERT GRAVEL, AND PYROLUSITE VEINS, TRACE FINE-GRAINED SAND.	▽ 6/6/86
SS 2"	16"	18"	13	6	6	7		20	4		INITIALLY BOREHOLE WAS LOGGED THROUGH HOLLOW STEM AUGERS. AFTER COMPLETION OF HOLE, 4-INCH PVC WAS INSTALLED AND BOREHOLE WAS RELOGGED.
SS 2"	18"	18"	21	6	9	12		25	5		
SS 2"	18"	24"	21	6	10	11		30	6		
							626.5	31.5		31.5 TO 37.0 FT SILTY CLAY, MODERATE YELLOWISH BROWN(10YR 5/4), MOIST, VERY STIFF.	
SS 2"	18"	25"	18	6	8	10	623.0	35	7		

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENNISON; P=PITCHER; O=OTHER

SITE	HOLE NO.
EAST OF RAFFINATE PIT NO. 2	G-15

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	2 OF 3	G-15

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							623.0	35				
							621.0	37			37.0 TO 41.0 FT GRAVELLY CLAY, DARK YELLOWISH ORANGE(10YR 6/6), MOIST, VERY STIFF, GRAVEL IS MODERATELY WEATHERED CHERT.	
SS 2"	18'	19'	67+	9	17	50/5"		40		8		
NXB WIRELINE	7.5'	4.45'	57				617.0	41		RUN #1	41.0 TO 70.7 FT LIMESTONE, DARK YELLOWISH ORANGE(10YR 6/6), HIGHLY TO MODERATELY WEATHERED, MEDIUM SOFT TO MEDIUM HARD, HORIZONTALLY FRACTURED WITH IRON STAINING, VUGGY, CHERT LENSES UP TO 0.3 FT IN THICKNESS.	41.0 TO 43.0 FT DRILLED WITH 2-7/8 INCH TRICONE ROLLER BIT. 43.0 TO 75.5 FT DRILLED WITH NXB WIRELINE CORE BIT.
NXB	1.5'	1.5'	100					50		R#2		
NXB	2.0'	2.35'	118	1.5 2.0	10 20	6 7				R#3		
NXB	1.2'	0.4		2.4 2.0	30 20	8 5				4	54.0 TO 54.4 FT SAND FILLED FRACTURE, HORIZONTAL FRACTURE WITH ROUGH PLANAR APERATURE. SAND IS DARK YELLOWISH ORANGE(10YR 6/6), MEDIUM-GRAINED, WITH CHERT GRAVEL.	
NXB	1.5	1.5'	100	1.5	10	5		55		5		
NXB WIRELINE	5.5'	4.7'	85					60		RUN #6	55.5 TO 61.0 FT HEALED FRACTURES ORIENTED 70° TO 80° RELATIVE TO CORE AXIS.	
NXB WIRELINE	9.5	9.5	100					65, 70		RUN #7	61.0 TO 70.5 FT THIN GRAYISH BLACK (N2) SHALE INTERBEDS.	
NXB WIRELINE	5.0	4.9	98				587.3	70.7		RUN #8	70.5 TO 75.5 FT LIMESTONE, MEDIUM LIGHT GRAY(N6), WITH CHERT NODULES, OCCASIONAL VUGS, AND OCCASIONAL STYLOLITES.	
							583.0	75				

RUN	AP (FT)	LP (FT)	RQD (%)
1	0.4	1.3	76
2	0.5	0.8	83
3	0.3	0.8	69
4	NA	NA	NA
5	0.8	1.2	83
6	0.4	0.9	75
7	0.5	1.4	65
8	1.0	1.6	97

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENNISON; P=PITCHER; O=OTHER

SITE: EAST OF RAFFINATE PIT NO. 2

HOLE NO. G-15

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	3 of 3	G-15

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS % / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							583.0	75				
							582.5	75.5			BOTTOM OF BORING AT 75.5 FT. BORING GROUTED TO SURFACE ON 6/12/86.	SINGLE NX PACKER LOST IN HOLE AND GROUTED IN. RQD=ROCK QUALITY DESIGNATION FOR EACH RUN. AP=AVERAGE LENGTH OF CORE PIECES. LP=LONGEST PIECE OF CORE FROM EACH RUN. ALL SOIL AND ROCK COLOR DESCRIPTIONS FROM THE <u>ROCK COLOR CHART</u> PRINTED BY THE GEOLOGICAL SOCIETY OF AMERICA, 1948.

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER

SITE: EAST OF RAFFINATE PIT NO. 2

HOLE NO. G-15

GEOLOGIC DRILL LOG

PROJECT: FUSRAP - WELDON SPRING SITE		JOB NO.: 14501-201	SHEET NO.: 1 OF 3	HOLE NO.: G-16	
SITE: FIELD ADJACENT TO ARMY PROPERTY	COORDINATES: N98,051 W51,007		ANGLE FROM HORIZ.: 90	BEARING: -	
BEGUN: 6/3/86	COMPLETED: 6/5/86	DRILLER: GEOTECHNOLOGY INC KURT JAEGER	DRILL MAKE AND MODEL: CME-45	HOLE SIZE: 6-1/4"/3"	OVERBURDEN (FT): 34.0
ROCK (FT): 46.4	TOTAL DEPTH: 80.4'	CORE RECOVERY (FT./%): 35.8/77	CORE BOXES: 5	SAMPLES: 7	EL. TOP OF CASING: -
GROUND EL.: 656.7	DEPTH/EL. GROUND WATER: 30.1'/626.6	DEPTH/EL. TOP OF ROCK: 34.0'/622.7	SAMPLE HAMMER WEIGHT/FALL: 140 LBS/30 IN	CASING LEFT IN HOLE: DIA./LENGTH: NONE	LOGGED BY: LAWRENCE YOUNG

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS or PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							656.7	0			
							656.2	.5		0 TO 0.5 FT SILTY CLAY, BLACK(N1), ORGANIC DEBRIS, TOPSOIL.	0-34.0 FT DRILLED WITH 6¼IN OD HOLLOW STEM AUGERS.
										0.5 TO 12.5 FT SILTY CLAY, MODERATE YELLOWISH BROWN(10YR 5/4), MOIST, VERY STIFF, WITH MEDIUM LIGHT GRAY SILT LENSES, AND LENSES OF BLACK(N1) ORGANIC DEBRIS.	
SS 2"	18"	12"	17	5	6	11			1		
								5			
SS 2"	18"	11"	17	4	7	10			2		
								10			0 TO 10.0 FT BOREHOLE WAS RADIOLOGICALLY LOGGED BY EBERLINE ANALYTICAL CORPORATION.
							644.2	12.5		12.5 TO 21.0 FT SILTY CLAY, BROWNISH GRAY(5YR 4/1), MOIST, VERY STIFF, TRACE TO SOME GRAVEL, TRACE FINE-GRAINED SAND, OXIDIZED NODULES.	
SS 2"	18"	12"	20	5	8	12			3		
								15			
SS 2"	18"	14"	15	5	6	9			4		
								20			
							635.7	21		21.0 TO 34.0 FT GRAVELLY CLAY, VERY LIGHT GRAY(N8), STIFF, MOIST, WITH SLIGHTLY WEATHERED, CHERT GRAVEL.	
SS 2"	16"	4"	73+	22	23	50/4"			5		
								25			29.0 TO 34.0 FT FALLING HEAD PERMEABILITY TEST
SS 2"	18"	10"	34	14	13	21			6		▽ 6/5/86
								30			34.0 FT AUGER REFUSAL
	1/2"	0	50+	50/1/2"							BURLINGTON/KEOKUK FM.
							622.7	34		34.0 TO 71.9 FT LIMESTONE, MODERATE YELLOWISH	
							621.7	35			

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER

SITE: FIELD ADJACENT TO ARMY PROPERTY

HOLE NO.: G-16

BECHTEL

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	2 OF 3	G-16

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS % PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	SAMPLE
							621.7	35	
NXB CORE	5.0	1.0	20						RUN #1
NXB CORE	1.5	0.7	47					40	R#2
NXB CORE	5.5	5.5	100					45	RUN #3
NXB CORE	10.0	8.9	89	13.4	5	15		50	RUN #4
				15.3	10	13		55	
				16.8	20	7			
NXB CORE	4.1	4.0	98					60	RUN #5
NXB CORE	2.0	2.0	100						RUN #6
NXB CORE	8.0	3.4	43					65	RUN #7
NXB CORE	1.5	1.4	93					70	R#8
NXB CORE	8.9	8.9	100				584.8	71.9	RUN #9
							581.7	75	

DESCRIPTION AND CLASSIFICATION

BROWN(10YR 5/4) TO MEDIUM GRAY(N5), SEVERELY TO MODERATELY WEATHERED, MEDIUM SOFT TO MEDIUM-HARD, VUGGY, HORIZONTALLY FRACTURED WITH IRON STAINING ON FRACTURE SURFACES, CHERT LAYERS AND LENSES RANGING IN THICKNESS FROM 0.5 TO LESS THAN 0.1 FT.

46.5 TO 56.5 FT ANGULAR CHERT FRAGMENTS AND INTERBEDS OF GREENISH GRAY(5G 6/1) TO GRAYISH OLIVE GREEN(5GY 3/2) SHALE.

56.5 TO 60.5 FT MODERATELY WEATHERED, WITH SMALL (<0.1 FT THICK) CHERT NODULES.

71.9 TO 80.4 FT LIMESTONE, MEDIUM LIGHT GRAY(N6), SLIGHTLY WEATHERED, HARD, MASSIVE, WITH LIGHT GRAY(N7), CHERT NODULES, BROWNISH GRAY(5YR 4/1) THIN (<.01 FT) SHALE INTERBEDS, AND STYLOLITES.

NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.

34.0 - 34.5 FT DRILLED WITH ROLLER BIT TO START COREHOLE.
34.5 - 80.4 FT DRILLED WITH NXB WIRELINE BIT USING CLEAN WATER.

44.5 FT COMPLETE WATER LOSS.

RUN	AP (FT)	LP (FT)	R[illegible]
1	0.1	0.3	
2	0.1	0.3	
3	0.3	1.1	7
4	0.3	1.[illegible]	43
5	0.4	1.0	86
6	0.3	0.5	60
7	0.3	0.5	52
8	0.4	0.6	70
9	1.0	1.8	87

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENNISON; P=PITCHER; O=OTHER

SITE	HOLE NO.
FIELD ADJACENT TO ARMY PROPERTY	G-16

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	3 of 3	G-16

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS % / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							581.7	75				
								80				
							576.3	80.4			BOTTOM OF BORING AT 80.4 FT. BORING GROUTED TO SURFACE ON 6/5/86.	APPROXIMATELY 20FT OF 1-1/4" PVC PIPE GROUTED IN HOLE. RQD=ROCK QUALITY DESIGNATION FOR EACH RUN. AP=AVERAGE LENGTH OF CORE PIECES. LP=LONGEST PIECE OF CORE FROM EACH RUN. ALL SOIL AND ROCK COLOR DESCRIPTIONS FROM THE ROCK COLOR CHART PRINTED BY THE GEOLOGICAL SOCIETY OF AMERICA 1948.

	SITE	HOLE NO.
SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER	FIELD ADJACENT TO ARMY PROPERTY	G-16

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	1 OF 3	G-18

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
PATROL ROAD, N W CORNER OF SITE	N101,350 W52,551	90	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
6/18/86	6/23/86	GEOTECHNOLOGY INC. KURT JAEGER/GEORGE MATTHEWS	CME 45/CME 750	6-1/4"/3"	36.0	43.0	79.0

CORE RECOVERY(FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
- 38/88	5	3	-	633.8	4.0'/592.8	36.0'/597.8

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 LBS/30 IN	NONE	LAWRENCE YOUNG/A.ATKINSON

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS "N" PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M. 1ST 6"	PRESSURE P.S.I. 2ND 6"	TIME IN MINUTES 3RD 6"	ELEVATION	DEPTH	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							633.8	0		0 TO 5.0 FT CLAYEY SILT, MODERATE YELLOWISH BROWN(10YR 5/4), DRY, SOME ORGANIC DEBRIS, VERY STIFF TO HARD.	0-17.5 FT DRILLED WITH 6 1/4IN OD HOLLOW STEM AUGERS USING CENTER PLUG.
SS 2"	18"	13"	27	4	13	14			1		
							628.8	5		5.0 TO 17.5 FT SILTY CLAY, DARK YELLOWISH ORANGE(10YR 6/6), MOIST, STIFF TO VERY STIFF, SOME FINE GRAVEL. OXIDIZED ZONES, PYROLUSITE VEINS AND STRINGERS.	0 TO 10.0 FT BOREHOLE WAS RADIOLOGICALLY LOGGED BY EBERLINE ANALYTICAL CORPORATION.
SS 2"	18"	14"	12	3	5	7			2		
								10			
SS 2"	18"	17"	19	3	9	10			3		
								15			
2-7/8" TRICONE BIT							616.3	17.5			17.5 FT AUGER REFUSAL. DRILLED FROM 17.5 TO 36.0 USING TRICONE ROLLER BIT - NO SAMPLE RECOVERY.
								20			
								25			
											WATER LOST AT 29'
								30			
							598.8	35			

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER	SITE	HOLE NO.
	PATROL ROAD, N W CORNER OF SITE	G-18

BECHTEL

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	2 of 3	G-18

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS / % PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							598.8	35			
NXB WIRELINE CORE BARREL WITH DIAMOND BIT							597.8	36		36.0 TO 71.7 FT LIMESTONE, MODERATELY WEATHERED, BEIGE TO YELLOW LIMESTONE W/ OCCASIONAL GRAY ZONES, MODERATELY TO HIGHLY FRACTURED, LOCALLY EXTREMELY FRACTURED, LOCAL DISSOLUTION. LIMESTONE IS SOFT TO MODERATELY HARD, CHERT IS HARD TO VERY HARD. OCCASIONAL CALCITE FILLED VUGS. BECOMES FRESHER, LESS FRACTURED BELOW 64 FT, STYLOLITES BELOW 64 FT.	BURLINGTON/KEOKUK FM.
	7.0'	4.0'	57	18.1	10	5			RUN #1		
				20.4	20	5		40			6/23/86
				17.0	10	5					
	6.0'	4.7'	78					45	RUN #2		
	4.0'	3.4'	85					50	RUN #3		
	6.0'	6.0'	100					55	RUN #4		
	10.0'	9.9'	99					60, 65	RUN #5		
								70			
	10.0'	10.0'	100				562.1	71.7	RUN #6	71.7 TO 79.0 FT LIMESTONE, GRAY, CRYSTALLINE, IRREGULAR OCCURENCES OF GRAY CHERT, FOSSILIFEROUS, SLIGHTLY WEATHERED TO FRESH, HARD LIMESTONE AND AND VERY HARD CHERT, SLIGHTLY TO MODERATELY FRACTURED, MOST ARE	
							558.8	75			

RUN	AP (FT)	LP (FT)	RQD (%)
1	0.2	0.45	31
2	0.2	0.7	45
3	0.2	0.5	31
4	0.3	0.8	77
5	0.3	0.7	59
6	0.3	1.2	62

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER

SITE: PATROL ROAD N W CORNER OF SITE

HOLE NO. G-18

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	3 of 3	G-18

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS % / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							558.8	75			NEARLY HORIZONTAL. PRESSURE SOLUTION ACCUMULATES OF SOFT TO MODERATELY SOFT DARK GREEN TO BLACK MATERIAL AT 77.3 TO 77.4 FT, 78.0 FT, 78.2 TO 78.3 FT, AND 78.5 FT.	
							554.8	79			BOTTOM OF BORING AT 79.0 FT. BORING GROUTED TO SURFACE ON 6/23/86. RQD=ROCK QUALITY DESIGNATION FOR EACH RUN. AP=AVERAGE LENGTH OF CORE PIECES. LP=LONGEST PIECE OF CORE FROM EACH RUN.	ALL SOIL AND ROCK COLOR DESCRIPTIONS FROM THE ROCK COLOR CHART PRINTED BY THE GEOLOGICAL SOCIETY OF AMERICA, 1948.

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER	SITE: PATROL ROAD N W CORNER OF SITE	HOLE NO. G-18

BECHTEL

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	1 of 2	G-19

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
NORTH PERIMETER PATROL ROAD	N101,700 W51,950	90	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
6/19/86	6/29/86	GEOTECHNOLOGY KURT JAEGER/GEORGE MATTHEWS	CME-45/CME-750	6-1/4"/3"	41.5	24.5	66.0'

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
20.5/82	3	9	-	619.4	40.5'/578.9	41.5'/577.9

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 LBS/30 IN	NONE	LAWRENCE YOUNG/E.BERGLUND

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M. (1ST 6")	PRESSURE P.S.I. (2ND 6")	TIME IN MINUTES (3RD 6")	ELEVATION	DEPTH	SAMPLE
							619.4	0	
							618.9	0.5	
SS 2"	18"	6"	7	3	3	4		5	1
ST	2'	2'	PUSHED @ 900 PSI						2
SS 2"	18"	9"	37	7	17	20		10	3
SS 2"	18"	16"	30	4	13	17		15	4
SS 2"	3"	0	50+	50/3"			600.6	18.8	5
SS 2"	1"	0	50+	50/1"				25	6
SS 2"	18"	14"	22	26	11	11		30	7
SS 2"	18"	8"	46	9	12	34	584.4	35	8

DESCRIPTION AND CLASSIFICATION

0 TO 0.5 FT GRAVEL, LIGHT GRAY(N7), WITH BLACK(N1) FLYASH MATRIX, DRY, ROADBED.

0.5 TO 18.8 FT SILTY CLAY, DARK YELLOWISH ORANGE(10YR 6/6), MOTTLED WITH MEDIUM GRAY(N5) SILT LENSES, MOIST, MEDIUM STIFF TO HARD, TRACE TO SOME GRAVEL, PYROLUSITE STRINGERS AND VEINS, OXIDIZED ZONES.

18.8 TO 41.5 FT GRAVELLY CLAY/WEATHERED LIMESTONE, MODERATE REDDISH BROWN (10R 4/6) TO MODERATE BROWN(5YR 3/4) SILTY CLAY, CHERT GRAVEL, MOIST TO WET, VERY STIFF TO HARD, OCCASIONAL SEMI-COMPETENT CHERT LAYERS, WITH DECOMPOSED LIMESTONE.

NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.

0-41.5 FT DRILLED WITH 6-1/4" OD HOLLOW STEM AUGERS USING CENTER PLUG.

0 TO 10.0 FT BOREHOLE WAS RADIOLOGICALLY LOGGED BY EBERLINE ANALYTICAL CORPORATION.

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENNISON; P=PITCHER; O=OTHER

SITE	HOLE NO.
NORTH PERIMETER PATROL ROAD	G-19

BECHTEL

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	2 of 2	G-19

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	WATER PRESSURE TESTS: PRESSURE P.S.I.	WATER PRESSURE TESTS: TIME IN MINUTES	ELEVATION	DEPTH	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							594.4	35			
SS 2"	18"	8"	1	17	1	0		40	9	39.5 TO 40.0 FT CAVITY.	6/24/86
NXB 3"	8'	4.5'	56%	PACKER TEST 41.0' - 47.0' 17.5 20.0 17.4	 10 20 10	 5 5 5	577.9	41.5 45	RUN #1	41.5 TO 49.2 FT LIMESTONE, DUSKY YELLOW (5Y 6/4), MODERATELY WEATHERED, MODERATELY HARD, MODERATELY FRACTURED WITH HORIZONTAL FRACTURES, WITH LIGHT GRAY (N7), HARD, CHERT INTERBEDS, FILLED VOIDS, AND NODULES UP TO 4 INCHES IN DIAMETER. FRACTURES FILLED WITH MODERATE YELLOWISH BROWN (10YR 5/4) CLAY. FEW OPEN VOIDS 1/4 TO 1/2 INCH IN DIAMETER.	AUGER REFUSAL AT 41.5' BURLINGTON/KEOKUK FM. 41.5 TO 66.0 FT CORED WITH NXB WIRELINE DIAMOND IMPREGNATED BIT USING FRESH WATER.
NXB 3"	9'	8.5'	94%	PACKER TEST 51.0' - 57.0' 0 0	 10 20	 5 5		50 55	RUN #2	49.2 TO 66.0 FT LIMESTONE, LIGHT GRAY (N6.5), SLIGHTLY WEATHERED, HARD, HIGH TO MODERATELY FRACTURED WITH HORIZONTAL FRACTURES. LIGHT GRAY (N7), HARD CHERT FILLED VOIDS, INTERBEDS, AND NODULES, FEW FOSSILS. 49.2 TO 50.7 HIGHLY FRACTURED WITH 80% CHERT.	RUN / AP (FT) / LP (FT) / RQD (%) 1 / 0.15 / 0.95 / 29 2 / 0.25 / 0.85 / 52 3 / 0.25 / 0.9 / 52
NXB 3"	8'	7.5'	94%				553.4	60 65 66	RUN #3	60.0 TO 61.8 FT VERTICAL FRACTURE. 65.6 FT FRACTURE FILLED WITH BLUE CLAY.	
								70 75		BOTTOM OF BORING AT 66.0 FT. BORING GROUTED TO SURFACE ON 6/24/86. RQD=ROCK QUALITY DESIGNATION FOR EACH RUN. AP=AVERAGE LENGTH OF CORE PIECES. LP=LONGEST PIECE OF CORE FROM EACH RUN.	ALL SOIL AND ROCK COLOR DESCRIPTIONS FROM THE ROCK COLOR CHART PRINTED BY THE GEOLOGICAL SOCIETY OF AMERICA 1948.

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER	SITE	HOLE NO.
	NORTH PERIMETER PATROL ROAD	G-19

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	1 of 2	G-20

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
PATROL ROAD - NORTH CENTRAL PORTION OF SITE	N101,850 W50,950	90	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
6/19/86	6/23/86	GEOTECHNOLOGY INC. KURT JAEGER	CME-45	6-1/4"/3"	32.5	33.5	66.0'

CORE RECOVERY(FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
~30.9/92	4	7	-	630.3	44.30'/586.0	32.5'/597.8

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 LBS/30 IN	NONE	LAWRENCE YOUNG / A.ATKINSON

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS "N" PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M. / 1ST 6"	PRESSURE P.S.I. / 2ND 6"	TIME IN MINUTES / 3RD 6"	ELEVATION	DEPTH	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							630.3	0		0 TO 6.0 FT CLAYEY SILT, MODERATE BROWN (5YR 3/4), DRY, MEDIUM STIFF, TRACE ORGANIC DEBRIS.	0-32.5 FT DRILLED WITH 6-1/4IN OD HOLLOW STEM AUGERS USING CENTER PLUG.
SS 2"	18"	16"	10	3	4	6		5	1		
ST	2'	1.9'	PUSHED @ 900 PSI					6	2	6.0 TO 16.5 FT SILTY CLAY, DARK YELLOWISH ORANGE(10YR 6/6), MOIST, VERY STIFF, SOME GRAVEL, MOTTLED WITH LIGHT GRAY (N7) SILT LENSES, PYROLUSITE VEINS AND STRINGERS.	
SS 2"	18"	15"	18	4	7	11	620.3	10	3		0 TO 10.0 FT BOREHOLE WAS RADIOLOGICALLY LOGGED BY EBERLINE ANALYTICAL CORPORATION.
SS 2"	18"	18"	20	6	9	11		15	4		
								16.5		16.5 TO 32.5 FT GRAVELLY CLAY, DARK YELLOWISH ORANGE(10YR 6/5) TO MODERATE REDDISH BROWN(10R 4/6), HARD, MOIST WITH MEDIUM GRAY(N5) TO VERY LIGHT GRAY (N8) CHERT GRAVEL AND SEMI-COMPETENT CHERT LAYERS, WITH DECOMPOSED LIMESTONE.	
SS 2"	5.5"	3"	50+	50/5.5"			610.3	20	5		
SS 2"	1"	1"	50+	50/1"				25	6		32.5 FT AUGER REFUSAL. 32.5 TO 66.0 FT CORED WITH NXB WIRELINE DIAMOND IMPREGNATED BIT USING WATER.
SS 2"	18"	10"	39	12	21	18		30	7		
	3.5'	2.4'	69				597.8	32.5	RUN 1	32.5 TO 59.7 FT LIMESTONE, TAN TO BEIGE, MODERATELY WEATHERED, SOFT TO VERY HARD, CRYSTALLINE, HIGH PERCENTAGE OF WHITISH-GRAYISH CHERT, OCCASIONAL LARGE CRYSTAL,	BURLINGTON/KEOKUK FM.
							595.3	35			

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER

SITE	HOLE NO.
PATROL ROAD - NORTH CENTRAL PORTION OF SITE	G-20

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	2 of 2	G-20

Sample type and diameter: NXB WIRELINE CORE BARREL WITH DIAMOND BIT

Sampler advance / Length core run	Sample recovery / Core recovery	Sample blows or Percent core recovery	Loss in G.P.M.	Pressure P.S.I.	Time in minutes	Elevation	Depth
						595.3	35
5.0	4.2	84					
5.0	4.6	92	13.5	10	5		
			11.2	20	5		
5.0	5.0	100	4.0	10	5		
5.0	4.7	94					
5.0	5.0	100				570.5	59.8
5.0	5.0	100				564.3	66

Depth scale: 35, 40, 45, 50, 55, 59.8, 65, 66

DESCRIPTION AND CLASSIFICATION

OF CALCITE, OCCASIONAL STYLOLITES, SOME VUGGY, OPEN ZONES.

59.7 TO 59.8 FT BANDS OF DARK GRAY CLAYEY MATERIAL - POSSIBLY PRESSURE SOLUTION ACCUMULATE.

59.8 TO 66.0 FT LIMESTONE, LIGHT GRAY TO BLUE GRAY, HARD TO VERY HARD, SLIGHTLY WEATHERED CRYSTALLINE, FINE TO MEDIUM-GRAINED, LIGHT BLUE CHERT OCCURING IN IRREGULAR PATCHES, SLIGHTLY FRACTURED WITH BROWN OR BLACK COATING OR STAINING ON FRACTURES, OCCASIONAL EVIDENCE OF DISSOLUTION, FOSSILIFEROUS.

BOTTOM OF BORING AT 66.0 FT. BORING GROUTED TO SURFACE ON 6/23/86.

RQD=ROCK QUALITY DESIGNATION FOR EACH RUN.
AP=AVERAGE LENGTH OF CORE PIECES.
LP=LONGEST PIECE OF CORE FROM EACH RUN.

NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.

NO WATER RETURN DURING CORING.

RUN	AP (FT)	LP (FT)	RQD (%)
1	0.3	0.5	75
2	0.35	0.8	83
3	0.2	0.8	76
4	0.3	0.9	60
5	0.4	0.7	83
6	0.2	0.5	92
7	0.5	1.0	82

ALL SOIL AND ROCK COLOR DESCRIPTIONS FROM THE ROCK COLOR CHART PRINTED BY THE GEOLOGICAL SOCIETY OF AMERICA, 1948.

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER

SITE	HOLE NO.
PATROL ROAD - NORTH CENTRAL PORTION OF SITE	G-20

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	1 OF 2	G-21

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
300 FT N W OF ASH POND	N101,336 W52,116	90	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
7/9/86	8/1/86	GEOTECHNOLOGY INC.	CME-55	6"/3"	54.0	40.5	74.5'

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
24.4/60	3	8	-	638.7	52.0'/587.0	54.0'/584.7

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 LBS/30 IN	NONE	A. ATKINSON

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS / % PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M. (1ST 6")	PRESSURE P.S.I (2ND 6")	TIME IN MINUTES (3RD 6")	ELEVATION	DEPTH	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							638.7	0			
6" HSA							638.2	0.5		0 TO 0.5 FT GRAVEL, LIGHT GRAY(N7), LIMESTONE, IN BLACK SILTY ASH MATRIX.	0-34.2 FT DRILLED WITH 6IN OD HOLLOW STEM AUGERS USING CENTER PLUG.
SS 2"	18"	12"	25	6	12	13		5	SS-1	0.5 TO 7.0 FT SILT, ORANGE(10YR 4/5) AND GREENISH GRAY(5GY 5/1), SOME CLAY. BLACK NODULES, VERY STIFF.	
6" HSA							631.7	7		7.0 TO 12.0 FT SILTY CLAY, MOTTLED ORANGE?(10YR 4/5) AND GRAY(5GY 5/1), VERY STIFF.	
SS 2"	18"	10.5"	26	7	12	14		10	SS-2		0 TO 10.0 FT BOREHOLE WAS RADIOLOGICALLY LOGGED BY EBERLINE ANALYTICAL CORPORATION.
6" HSA							626.7	12		12.0 TO 23.8 FT SILTY CLAY, YELLOWISH ORANGE(10YR 6/6 TO 10YR 5/4), ORANGE (5YR 4/4 TO 10YR 4/6), AND GRAY(5Y 5/1) MOTTLED, VERY STIFF TO HARD, BLACK(N1) MANGANESE OXIDE STAINING COMMON.	
SS 2"	18"	14"	30	6	11	19		15	SS-3		
6" HSA											
ST 3"	24"	25"							ST-1		
SS 2"	18"	18"	41	13	16	25		20	SS-4		
6" HSA											
SS2"	9"	13.5"	50/3"	42	50/3"	-	614.9	23.8	5	23.8 TO 27.0 FT CLAYEY SILT, PALE YELLOWISH BROWN(10YR 6.5/2), HARD, DRY, ORANGE AND BLACK STAINING.	34.2 TO 74.5 FT CORED WITH NXB WIRELINE DIAMOND IMPREGNATED BIT USING WATER.
6" HSA								25			
							611.7	27		27.0 TO 34.2 FT GRAVELLY CLAY, WHITE (N9) TO OLIVE GRAY(5Y 5/1) ANGULAR CHERT IN ORANGE(10YR 4/6) CLAY MATRIX, VERY STIFF.	
SS 2"	18"	10"	29	10	14	15		30	SS-6		34.2 FT AUGER REFUSAL.
6" HSA											
SS2"	7"	5"	50/1"	50	50/1"	-	604.5	34.2	7		BURLINGTON/KEOKUK FM.
							603.7	35		34.2 TO 54.0 FT LIMESTONE, DARK	

	SITE	HOLE NO.
SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENNISON; P=PITCHER; O=OTHER	300 FT N W OF ASH POND	G-21

BECHTEL

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	2 OF 2	G-21

Sample type and diameter: NXBWIRELINE CORE BARREL WITH DIAMOND BIT

Sampler advance / Length core run	Sample recovery / Core recovery	Sample blows / Percent core recovery	Water pressure tests: Loss in G.P.M.	Pressure P.S.I.	Time in minutes	Elevation	Depth	Sample	Description and classification
						603.7	35		
5.0	0.9	18						RUN #1	YELLOWISH ORANGE (10YR 6/6), EXTREMELY WEATHERED TO DECOMPOSED, CHERT AND LIMESTONE FRAGMENTS IN CLAY MATRIX. CHERT FRAGMENTS OCCASIONAL EXHIBIT DENDRITES AND ARE ANGULAR AND VUGGY.
5.0	0.4	8					40	RUN #2	
5.0	1.2	24					45	RUN #3	
3.0	1.1	37					50	RUN #4	
2.0	0.6	30						RUN #5	
						584.7	54		
3.0	2.4	80					55	RUN #6	54.0 TO 68.5 FT LIMESTONE, TAN TO BEIGE, MODERATELY WEATHERED, MODERATELY HARD, YELLOW-GRAY CHERT IN IRREGULAR BANDS AND PATCHES.
5.0	5.0	100					60	RUN #7	
4.0	4.0	100	0.3	20	6		65	RUN #8	63.7 TO 65.2 FT QUARTZ FILLED VUGGY ZONE.
4.5	4.5	100	0.1	30	5			RUN #9	
						570.2	68.5		
			0	20	5		70		68.5 TO 74.5 FT LIMESTONE, WHITE TO LIGHT GRAY, FRESH, HARD, CRYSTALLINE, VERY HARD, GRAY CHERT IN LENSES AND PATCHES, OCCASIONAL PRESSURE SOLUTION STYLOLITES.
4.0	3.9	98						RUN #10	
						564.2	74.5		BOTTOM OF BORING AT 74.5 FT. BORING GROUTED TO SURFACE ON 8/1/86.

NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.

RUN	AP (FT)	LP (FT)	RQD (%)
1	0.1	0.2	0
2	0.0	0.0	0
3	0.15	0.45	38
4	0.0	0.15	0
5	0.0	0.1	0
6	0.3	1.0	58
7	0.5	1.2	91
8	0.9	2.4	98
9	0.5	1.2	90
10	0.6	1.4	85

▽ 7/31/86

RQD=ROCK QUALITY DESIGNATION FOR EACH RUN.
AP=AVERAGE LENGTH OF CORE PIECES.
LP=LONGEST PIECE OF CORE FROM EACH RUN.

ALL SOIL AND ROCK COLOR DESCRIPTIONS FROM THE ROCK COLOR CHART PRINTED BY THE GEOLOGICAL SOCIETY OF AMERICA, 1948.

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENNISON; P=PITCHER; O=OTHER

SITE: 300 FT N W OF ASH POND

HOLE NO. G-21

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	1 of 2	GW-1

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
500 FT. WEST OF ASH POND	N100,858 W52,554	90	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
7/10/86	7/14/86	GEOTECHNOLOGY INC.	CME-55	6"/3"	26.5	33.5	60.0'

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
30.95/92	4	4	-	612.1	23.3'/588.8	26.5'/585.6

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 LBS/30 IN	2"/61'	A.ATKINSON / E.BERGLUND

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS % PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN GPM (1ST 6")	PRESSURE P.S.I. (2ND 6")	TIME IN MINUTES (3RD 6")	ELEVATION	DEPTH	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							612.1	0			
							611.6	0.5		0.0 TO 0.5 FT ORGANIC DEBRIS - LEAVES ROOTS, ETC.	0-14.7 FT DRILLED WITH 6-INCH OD HOLLOW STEM AUGER USING CENTER PLUG.
										0.5 TO 6.0 FT SILT (ML): BROWN TO LIGHT BROWN CLAYEY SILT WITH BLACK AND RUST STAINED NODULES.	
SS 2"	18"	13"	61	19	33	28		5	SS-1		
								6		6.0 TO 14.7 FT GRAVELLY CLAY (GC): WHITEISH TO YELLOW - GRAY (10YR 8/2) CHERT IN ORANGE (10YR 4/4 TO 10YR 6/6) CLAY MATRIX.	0 TO 10.0 FT BOREHOLE WAS RADIOLOGICALLY LOGGED BY EBERLINE ANALYTICAL CORPORATION.
SS 2"	18"	15"	45	11	20	25		10	SS-2		
ST 3"	24"	17"							ST-1		
SS 2"	14"	13"	63+	11	13	50/2"	597.4	14.7 / 15	SS-3		14.5 FT AUGER REFUSAL. 14.5 TO 26.5 FT DRILLED THRU CLAY AND FRACTURED CHERT WITH TRICONE BIT TO TOP OF SOUND BEDROCK.
2-7/8" TRICONE								20		14.7 TO 26.5 FT GRAVELLY CLAY, ORANGE (10YR 4/4 TO 10YR 6/6) CLAY WITH CHERT GRAVEL AND SEMICOMPETENT CHERT LAYERS.	RESIDUUM
								25			▽ 7/14/86
NXB	0.5'	0.5'	100%				585.6	26.5	1		BURLINGTON/KEOKUK FM. 26.5 TO 60.0 FT CORED USING NXB WIRELINE DIAMOND IMPREGNATED CORE BIT AND FRESH WATER.
NXB 3"	5'	4.65'	93%	0	10	5		30	RUN #2	26.5 TO 40.5 FT LIMESTONE, YELLOWISH BROWN (10YR 5/4), MODERATELY WEATHERED TO DECOMPOSED, MODERATELY TO SLIGHTLY FRACTURED, MODERATELY HARD, WITH MEDIUM GRAY (N6), HARD CHERT FILLED VOIDS. 34.5 TO 39.5 FT CLAY SEAMS.	RUN #1: RQD = 0 %, AP = <0.1 FT, LP = 0.1 FT
NXB 3"	5'	4.3'	86%	0	20	5	577.1	35	RUN #3		RUN #2: RQD = 11%, AP = 0.3 FT, LP = 0.5 FT

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER	SITE	HOLE NO.
	500 FT WEST OF ASH POND	GW-1

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	2 of 2	GMW-1

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS or PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN GPM	PRESSURE PSI	TIME IN MINUTES	ELEVATION	DEPTH	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							577.1	35			RUN #3 RQD = 35% AP = 0.25 FT LP = 0.45 FT
NXB 3"	5'	4.8'	96%					40	RUN #4	39.5 TO 40.5 FT DECOMPOSED.	RUN #4 RQD = 48% AP = 0.3 FT LP = 0.7 FT
NXB 3"	5'	4.0'	80%				571.6	40.5 45	RUN #5	40.5 TO 53.5 FT LIMESTONE, LIGHT GRAY (N7), SLIGHTLY WEATHERED, MODERATELY HARD, SLIGHTLY HORIZONTALLY FRACTURED, WITH HARD, VERY LIGHT GRAY (N8) CHERT FILLED VOIDS.	RUN #5 RQD = 41% AP = 0.25 FT LP = 0.8 FT
NXB 3"	2'	2.0'	100%						RUN #6		RUN #6 RQD = 20% AP = 0.1 FT LP = 0.9 FT
NXB 3"	3'	2.9'	97%					50	RUN #7	53.0 TO 53.5 FT YELLOWISH BROWN (10YR 5/4)DECOMPOSED ZONE.	RUN #7 RQD = 47% AP = 0.2 FT LP = 0.55 FT
NXB 3"	5'	4.8'	96%				558.6	53.5 55	RUN #8	53.5 TO 60.0 FT LIMESTONE, MEDIUM GRAY (N6), FRESH, SLIGHTLY HORIZONTALLY FRACTURED, MODERATELY HARD, WITH LIGHT BLUE GRAY (5B 5/1), HARD CHERT FILLED VOIDS, OCCASIONAL STYLOLITES.	RUN #8 RQD = 73% AP = 0.3 FT LP = 0.9 FT
NXB 3"	3'	3.0'	100%						RUN #9		RUN #9 RQD = 82% AP = 0.3 FT LP = 0.7 FT
							552.1	60		BOTTOM OF BORING AT 60.0 FT. REAMED HOLE TO 8-1/2 INCH AND INSTALLED 2-INCH 316L STAINLESS STEEL MONITORING WELL SCREENED FROM 48.0 TO 58.0 FT.	
										AP=AVERAGE LENGTH OF CORE PIECES FROM EACH RUN. LP=LONGEST PIECE OF CORE FROM EACH RUN. RQD=ROCK QUALITY DESIGNATION FOR EACH RUN.	ALL SOIL AND ROCK COLOR DESCRIPTIONS FROM THE ROCK COLOR CHART, PRINTED BY THE GEOLOGICAL SOCIETY OF AMERICA, 1948.

	SITE	HOLE NO.
SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER	500 FT WEST OF ASH POND	GMW-1

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	1 of 2	GMW-2/2A

SITE	COORDINATES		ANGLE FROM HORIZ.	BEARING
WEST SIDE OF ASH POND	GMW-2 N100,650 GMW-2A N100,658	W52,250 W52,253	90	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
7/1/86	7/22/86	GEOTECHNOLOGY INC.	MOBILE B-57	6"/3"	24.5	35.5	60.0

CORE RECOVERY(FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
26.4/74	GMW-2 (2) GMW-2A (3)	6	-	624.0	31.0/593.0	29.0/595.0

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 LBS/30 IN	2"/61.0'	A.ATKINSON

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS OF / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M. 1ST 6"	PRESSURE P.S.I. 2ND 6"	TIME IN MINUTES 3RD 6"	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							624.0	0				
6" HSA											0 TO 3.5 FT SILTY CLAY, TAN-BROWN, WITH LIMESTONE GRAVEL.	0-24.5 FT DRILLED WITH 6IN OD HOLLOW STEM AUGER USING CENTER PLUG.
SS 2"	18"	11"	25	4	15	10	620.5	3.5		SS-1	3.5 TO 7.0 FT CLAY, OLIVE BROWN (5Y 4/6) WITH WOOD CHIPS AND BROWN (10YR 6/4) ANGULAR CHERT FRAGMENTS.	
6" HSA								5				0 TO 10.0 FT BOREHOLE GMW-2 WAS RADIOLOGICALLY LOGGED BY EBERLINE ANALYTICAL CORPORATION.
SS 2"	18"	14"	7	3	3	4	617.0	7		SS-2	7.0 TO 12.5 FT CLAYEY SILT, DARK OLIVE GRAY (5Y 4/2- 10YR 4/2), SOFT, MOIST.	
6" HSA								10				HOLE GMW-2 WAS ABANDONED WHEN A DIAMOND DRILL BIT AND REAMING SHELL WERE BROKEN OFF IN THE HOLE AT A DEPTH OF 45.5 FT. HOLE GMW-2A WAS DRILLED TO REPLACE GMW-2.
ST	12"	13"								ST-1		
SS 2"	18"	13"	26	15	9	17	611.5	12.5		SS-3	12.5 TO 24.5 FT GRAVELLY CLAY, ANGULAR CHERT FRAGMENTS IN A CLAY/SILTY CLAY MATRIX. 12.5 TO 13.0 FT BROWN (5YR 3/6) SILTY CLAY WITH CHERT GRAVEL. 13.0 TO 14.0 FT MOTTLED GRAY (N5) AND RED (10YR 3/6) CLAY WITH WHITISH (N9 TO 10YR 7/4) CHERT GRAVEL.	
6" HSA								15				
SS 2"	9"	9.5"	50/3"	10	50/3"	-				4	18.5 TO 19.2 FT ORANGE (10YR 5.5/6) SILTY CLAY WITH WHITE (N9) CHERT GRAVEL.	
6" HSA								20			23.5 TO 23.9 FT ORANGE (10YR 6/6)SILTY CLAY WITH WHITE (N9) CHERT GRAVEL.	24.5 FT AUGER REFUSAL. BURLINGTON/KEOKUK FM. 24.5 TO 60.0 FT CORED WITH NXB WIRELINE DIAMOND IMPREGNATED CORE BIT USING WATER.
SS 2"	4"	6"	50/4"	50/4"	-	-				5		
HSA							599.5	24.5				
NXB CORE BARREL W/ DIAMOND BIT	4.0	0.2	5					25		RUN #1	24.5 TO 29.0 FT LIMESTONE, EXTREMELY WEATHERED TO DECOMPOSED, SOFT TO MODERATELY HARD.	
	1.2	1.0	83				595.0	29		2	29.0 TO 51.1 FT LIMESTONE, TAN TO YELLOW (5Y 7/3 TO 5Y8 8/2), MODERATELY HARD, MODERATELY WEATHERED, MODERATELY FRACTURED, OCCASIONAL HIGHLY WEATHERED ZONES WITH CLAY SEAMS, WHITE (N9) TO GRAY (N4), HARD, CHERT LENSES AND PATCHES, OCCASIONAL CRYSTAL FILLED VUGS.	
	2.8	2.0	71					30		RUN #3		▽ 7/12/86
	1.0	0.8	80	GMW 2A						RUN #4		END GMW-2, BEGIN GMW-2A
	5.0	4.3	86				589.0	35				

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER

SITE	HOLE NO.
WEST SIDE OF ASH POND	GMW-2/2A

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	M501-201	2 of 2	GMW-2/2A

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS % PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I	TIME IN MINUTES	ELEVATION	DEPTH	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
NXB CORE BARREL W/ DIAMOND BIT							589.0	35			RUN #1 RQD = 0 % AP = 0.1 FT LP = 0.1 FT
				0.9	15	5					
				3.2	30	6					RUN #2 RQD = 0 % AP = 0.2 FT LP = 0.3 FT
	5.0	4.6	92	1.9	15	5		40	RUN #5	41.2 FT HORIZONTAL FRACTURE FILLED WITH GRAYISH GREEN (10G 4/2) CLAY.	RUN #3 RQD = 35% AP = 0.2 FT LP = 0.4 FT
	5.0	2.8	56					45	RUN #6		RUN #4 RQD = 9 % AP = 0.2 FT LP = 0.4 FT
	5.0	4.8	96				572.9	50 / 51.1	RUN #7	50.7 FT HORIZONTAL FRACTURE FILLED WITH GRAYISH GREEN (10G 4/2) CLAY.	RUN #5 RQD = 35% AP = 0.2 FT LP = 0.5 FT
	5.0	5.0	100	0	15	5		55	RUN #8	51.1 TO 60.0 FT LIMESTONE, MEDIUM LIGHT GRAY (N6), SLIGHTLY WEATHERED TO FRESH, HARD, WITH OCCASIONAL VERY HARD CHERT NODULES AND BANDS, OCCASIONAL WEATHERED ZONES (52.0 FT, 53.7 TO 54.1 FT, 56.6 TO 57.1 FT), STYLOLITES, OCCASIONAL FOSSILS, SLIGHTLY FRACTURED WITH OCCASIONAL ZONES OF HIGH MECHANICAL FRACTURING.	RUN #6 RQD = 13% AP = 0.2 FT LP = 0.55 FT
				0	30	5					RUN #7 RQD = 66% AP = 0.3 FT LP = 0.8 FT
	2.0	0.9	45						RUN #9		RUN #8 RQD = 43% AP = 0.2 FT LP = 0.5 FT
							564.0	60		BOTTOM OF BORING AT 60.0 FT REAMED HOLE TO 8-1/2 INCH AND INSTALLED 2-INCH 316L STAINLESS STEEL MONITORING WELL SCREENED FROM 48.0 TO 58.0 FT.	
										BORING GMW-2 WAS GROUTED TO SURFACE ON 7/8/86.	SOIL AND ROCK COLOR DESCRIPTIONS FROM THE ROCK COLOR CHART, PRINTED BY THE GEOLOGICAL SOCIETY OF AMERICA, 1948.
										AP= AVERAGE LENGTH OF CORE PIECES FROM EACH RUN.	
										LP= LONGEST PIECE OF CORE FROM EACH RUN.	RUN #9 RQD = 0 % AP = 0.1 FT LP = 0.3 FT
										RQD= ROCK QUALITY DESIGNATION FOR EACH RUN.	

GRAPHIC LOG: limestone symbol from 35 to 60 ft.

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER	SITE: WEST SIDE OF ASH POND	HOLE NO. GMW-2/2A

![Bechtel logo]

GEOLOGIC DRILL LOG

GEOLOGIC DRILL LOG	PROJECT	JOB NO.	SHEET NO.	HOLE NO.
	FUSRAP - WELDON SPRING SITE	14501-201	1 of 2	GMW-3

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
SOUTHWEST OF ASH POND	N100,347 W52,299	90	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
6/30/86	7/21/86	GEOTECHNOLOGY INC	MOBILE B-57/CME 750	6"/3"	28.0'	31.0	59.0'

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
20.8/67	3	6	-	636.8	38.1'/598.7	38.8'/598.0

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 LBS/30 IN	2"/61'	A.ATKINSON/E.BERGLUND

SAMPLE TYPE AND DIAMETER	SAMPLE/RUN ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY/CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M. / 1ST 6"	PRESSURE P.S.I. / 2ND 6"	TIME IN MINUTES / 3RD 6"	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							636.8	0				
6" HSA							635.8	1			0 TO 1.0 FT GRAVEL, LIGHT GRAY (N7), LIMESTONE IN BLACK (N1) FLYASH MATRIX.	0-28.0 FT DRILLED WITH 6-INCH OD HOLLOW STEM AUGER WITH CENTER PLUG.
								5			1.0 TO 8.0 FT CLAYEY SILT, TAN TO LIGHT BROWN (5Y 5/4 TO 10YR 5/4), SOME BLACK MANGANESE OXIDE STAINING.	
SS 2"	18"	17"	12	4	5	7				SS-1		3.0 FT UNSUCCESSFUL ATTEMPT TO TAKE SHELBY TUBE SAMPLE.
6" HSA							628.8	8				
SS 2"	18"	18"	12	3	5	7		10		SS-2	8.0 TO 13.0 FT CLAY, MOTTLED ORANGE-BROWN-GRAY (10YR 5/4), STIFF, MINOR MANGANESE OXIDE STAINING.	
6" HSA												0 TO 10.0 FT BOREHOLE WAS RADIOLOGICALLY LOGGED BY EBERLINE ANALYTICAL CORPORATION.
ST 3"	24"	26"					623.8	13		ST-1		
SS 2"	18"	13"	19	4	8	11		15		SS-3	13.0 TO 22.0 FT SILTY CLAY, MOTTLED ORANGE, YELLOWISH BROWN, AND GRAY (10YR 5/6 TO 10YR 5/5), WITH FINE-GRAINED SAND AND WEATHERED ANGULAR CHERT GRAVEL, BLACK MANGANESE OXIDE STAINING AND FILLINGS COMMON.	
6" HSA												
SS 2"	18"	15"	14	5	6	8		20		SS-4		
6" HSA							614.8	22				
SS 2"	18"	13"	55	43	26	29		25		SS-5	22.0 TO 28.0 FT GRAVELLY CLAY, ORANGE AND GRAY (10YR5/5), HARD, WITH WHITISH (10YR8/2) AND BROWN (10YR6/4) ANGULAR CHERT GRAVEL.	
6" HSA							608.8	28				28.0 FT AUGER REFUSAL.
NXB 3"	6'	1.4'	23%	3.1	10	5		30		RUN #1	28.0 TO 38.8 FT GRAVELLY CLAY, ORANGE AND GRAY (10YR 5/5) SILTY CLAY, WITH HARD, GRAY (N6) CHERT GRAVEL AND SEMI-COMPETENT CHERT LAYERS OR NODULES.	28.0 TO 59.0 FT CORED WITH NXB WIRE LINE DIAMOND IMPREGNATED CORE BIT USING WATER. RESIDUUM
							601.8	35				

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER	SITE	HOLE NO.
	SOUTHWEST OF ASH POND	GMW-3

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	2 OF 2	GMW-3

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS PER 6" / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							601.8	35			
NXB 3"	5'	0.7'	14%						RUN #2		∇ 7/10/86 BURLINGTON/KEOKUK FM.
							598.0	38.8			
NXB 3"	5'	4.8'	96%					40	RUN #3	38.8 TO 48.5 FT LIMESTONE, YELLOWISH BROWN (10YR 5/4) TO LIGHT YELLOWISH GRAY (5Y 7/1), MODERATELY WEATHERED, MODERATELY HARD, MODERATELY FRACTURED, FRACTURES ARE HORIZONTAL WITH SOME FILLED WITH CLAY, VERY HARD, GRAY (N6) CHERT FILLED VOIDS, 40% OF CORE IS CHERT.	RUN #1 RQD = 0 % AP = 0.1 FT LP = 0.2 FT RUN #2 RQD = 0 % AP = <0.1 FT LP = 0.1 FT
NXB 3"	5'	4.6'	92%	0 0	10 20	5 5		45	RUN #4	45.6 TO 48.5 FT EXTREMELY WEATHERED AND FRACTURED ZONE WITH CLAY SEAMS.	RUN #3 RQD = 69% AP = 0.35 FT LP = 0.8 FT
							588.3	48.5			
NXB 3"	5'	4.6'	92%					50	RUN #5	48.5 TO 59.0 FT LIMESTONE, YELLOWISH BROWN (10YR 5/4), SLIGHTLY WEATHERED, MODERATELY HARD, SLIGHTLY FRACTURED, WITH LIGHT GRAY (N7), HARD, CHERT FILLED VOIDS, 20-30% OF CORE IS CHERT.	RUN #4 RQD = 33% AP = 0.25 FT LP = 1.1 FT RUN #5 RQD = 72% AP = 0.3 FT LP = 0.8 FT
NXB 3"	5'	4.7'	94%					55	RUN #6		RUN #6 RQD = 60% AP = 0.3 FT LP = 0.8 FT
							577.8	59		BOTTOM OF BORING AT 59.0 FT. REAMED HOLE TO 8-1/2 INCH AND INSTALLED 2-INCH 316L STAINLESS STEEL MONITORING WELL SCREENED FROM 48.0 TO 58.0 FT.	
										AP= AVERAGE LENGTH OF CORE PIECES FROM EACH RUN. LP= LONGEST PIECE OF CORE FROM EACH RUN. RQD= ROCK QUALITY DESIGNATION FOR EACH RUN.	SOIL AND ROCK COLOR DESCRIPTIONS FROM THE ROCK COLOR CHART, PRINTED BY THE GEOLOGICAL SOCIETY OF AMERICA, 1948.

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER

SITE	HOLE NO.
SOUTHWEST OF ASH POND.	GMW-3

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	1 of 2	GMW-4

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
500FT NORTH OF ASH POND	N101,450 W51,750	90	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
6/28/86	7/24/86	GEOTECHNOLOGY INC.	MOBILE B-57/CME 55	6"/3"	51.0	RESIDUUM 27-61 21	72.0'

CORE RECOVERY(FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
22.7/58	3	7	-	642.8	51.4'/591.4	51.0'/591.8

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 LBS/30 IN	2"/76.5'	A.ATKINSON/J.KAISER/E.BERGLUND

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS 6" / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M. 1ST 6"	PRESSURE P.S.I. 2ND 6"	TIME IN MINUTES 3RD 6"	ELEVATION	DEPTH	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							642.8	0			
6" HSA							642.3	0.5		0 TO 0.5 FT SILTY CLAY, BLACK (N1), DRY TO MOIST, LOW PLASTICITY, SOME ORGANICS, SOME FLYASH.	0-33.0 FT DRILLED WITH 6-INCH OD HOLLOW STEM AUGERS USING CENTER PLUG.
SS 2"	18"	14"	25	6	11	14		5	SS-1	0.5 TO 7.0 FT CLAYEY SILT, MOTTLED YELLOW-ORANGE (10YR 6/6) AND PALE OLIVE (10Y 6/2), VERY STIFF, LOW PLASTICITY, MOIST.	
6" HSA							635.8	7			
SS 2"	18"	16"	13	5	4	9		10	SS-2	7.0 TO 12.0 FT SILTY CLAY, MOTTLED YELLOWISH-BROWN, STIFF, HIGHLY PLASTIC, SAND-SIZE LIMESTONE FRAGMENTS, BLACK MANGANESE OXIDE STAINING.	0 TO 10.0 FT BORE-HOLE WAS RADIO-LOGICALLY LOGGED BY EBERLINE ANALYTICAL CORPORATION.
6" HSA							630.8	12			
ST 3"	24"	24"							ST-1	12.0 TO 27.0 FT SILTY CLAY, YELLOWISH BROWN (10YR 5.5/6), VERY STIFF, FEW ROUNDED PEBBLES AND SOME ANGULAR WEATH-ERED CHERT GRAVEL, BLACK MANGANESE OXIDE STAINING COMMON.	
SS 2"	18"	16"	29	9	14	15		15	SS-3		
6" HSA											
SS 2"	18"	19"	26	6	12	14		20	SS-4		
6" HSA											
SS 2"	18"	20.5"	31	10	13	18		25	SS-5		
6" HSA							615.8	27		27.0 TO 33.0 FT GRAVELLY CLAY, YELLOW-ORANGE-BROWN (10YR 4/5) CLAY WITH ANGULAR WEATHERED CHERT GRAVEL.	
SS 2"	6"	7"	50/3"	50/3"	-	-			6		
6" HSA								30			33.0 FT AUGER REFUSAL. INTERFACE PERMEABILITY TEST PERFORMED AT 33.0 FT.
6" TRICONE ROLLER BIT							609.8	33		33.0 TO 51.0 FT GRAVELLY CLAY, REDDISH BROWN, WITH WEATHERED CHERT GRAVEL AND LAYERS OR LENSES OF CHERT.	RESIDUUM
							607.8	35			

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENNISON; P=PITCHER; O=OTHER

SITE	HOLE NO.
500 FT NORTH OF ASH POND	GMW-4

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	2 of 2	GMW-4

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	SAMPLE
							607.8	35	
TRICONE 6"	d.	33'-37'							
NXB 3"	5'	1.6'	32%					40	RUN #1
NXB 3"	5'	0.7'	14%					45	RUN #2
NXB 3"	5'	1.0'	20%				591.8	50, 51	RUN #3
NXB 3"	3'	2.7'	90%	0	10	5		55	RUN #4
NXB 3"	2'	2.0'	100%	0	20	5			RUN #5
NXB 3"	5'	5.0'	100%					60	RUN #6
NXB 3"	5'	5.0'	100%	0	10	5		65	RUN #7
NXB 3"	5'	4.7'	94%				572.8	70	RUN #8
							570.8	72	

DESCRIPTION AND CLASSIFICATION

40.5 TO 41.5 FT DECOMPOSED LIMESTONE

51.0 TO 70.0 FT LIMESTONE, YELLOWISH BROWN (10YR 5/4), MODERATELY WEATHERED, MODERATELY HARD, FEW HORIZONTAL FRACTURES (CLAY FILLED), WITH HARD, MEDIUM GRAY (N7) CHERT FILLED VOIDS, CORE IS 20% CHERT.

55.0 TO 57.0 FT DECOMPOSED LIMESTONE WITH CLAY SEAMS, CORE IS 40 TO 50% CHERT.

59.0 TO 70.0 FT LIMESTONE BECOMES CLAYEY, IN SOME CASES FRIABLE.

61.0 TO 62.0 FT VERTICAL FRACTURE.

65.0 TO 69.0 FT IRREGULAR CHERT FILLED VOIDS IN DECOMPOSED LIMESTONE, CHERT IS WHITE (N9) TO GRAY (N6).

69.0 TO 70.0 FT SWIRLED PATTERN OF CLAYEY LIMESTONE AND CHERT.

70.0 TO 72.0 FT LIMESTONE, GRAY (N6), HARD SLIGHTLY WEATHERED, STYLOLITIC, CHERT, 70.7 TO 70.1 VERTICALLY FRACTURED CHERT INTERBED, IRON STAINED.

BOTTOM OF BORING AT 72.0 FT. REAMED HOLE TO 8-1/2 INCH AND INSTALLED 2-INCH 316L STAINLESS STEEL MONITORING WELL SCREENED FROM 65.5 TO 75.5 FT.

NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.

33.0 TO 37.0 FT WITH 6-INCH TRICONE ROLLER BIT USING WATER.
37.0 TO 72.0 FT CORED WITH NXB WITH LINE DIAMOND IMPREGNATED CORE BIT USING WATER.
41.0 FT WATER LOSS.

BURLINGTON/KEOKUK FM.

▽ 7/24/86

RUN	AP (FT)	LP (FT)	RQD
1	0.15	0.3	0%
2	0.1	0.2	0%
3	0.1	0.3	0%
4	0.2	0.35	26%
5	0.2	0.6	30%
6	0.35	0.85	63%
7	0.3	0.9	48%
8	0.35	0.85	85%

AP=AVERAGE LENGTH OF CORE PIECES FROM EACH RUN.
LP=LONGEST CORE PIECE FROM EACH RUN.
RQD=ROCK QUALITY DESIGNATION FOR EACH RUN.

SOIL AND ROCK COLOR DESCRIPTIONS FROM THE ROCK COLOR CHART, PRINT THE GEOLOGICAL SOCIETY OF AMERICA, 1948.

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER

SITE: 500 FT NORTH OF ASH POND

HOLE NO. GMW-4

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	1 of 3	GMW-5

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
NORTH END OF ASH POND DAM	N101,131 W51,950	90	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
7/1/86	7/22/86	GEOTECHNOLOGY INC. KURT JAEGER	CME-45	6"/3"	44.8	31.2	76.0 FT

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
30.45/70.3	4	7	-	635.7	NOT DETECTED	44.8FT/590.9

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 LBS/30 IN	2"/78.5'	J.E.KAISER

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH OF CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M. (1ST 6")	PRESSURE P.S.I. (2ND 6")	TIME IN MINUTES (3RD 6")	ELEVATION	DEPTH	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							635.7	0			
6"Ø HSA							635.2	0.5		0 - 0.5 FT SILTY CLAY (CL): BLACK(N1) LOW PLASTICITY. MOIST. ORGANICS. GRAVELS LOCALLY.	0-32.7 FT DRILLED WITH 6IN OD HOLLOW STEM AUGER USING CENTER PLUG.
										0.5 - 6 FT SILT (ML-MH): GRAYISH ORANGE(10YR 7/4). LOW PLASTICITY. MOIST. MOTTLED WITH LIGHT BLUISH GRAY (5B 7/1) SILT & CLAY.	
SS 2"	18"	12"	24	6	12	12		5	1		
6"Ø HSA							629.7	6		6 - 19.5 FT SILTY CLAY (CL): MOD. YELLOW BROWN(10YR 5/4) TO YELLOW ORANGE (10YR 6/6). MED. TO HIGH PLASTICITY. STIFF. MOIST. MOTTLED. TRACE FINE GRAVEL TO SAND SIZE PARTICLES OF LIMESTONE AND CHERT.	
SS 2"	18"	16"	12	3	4	8		10	2		0 TO 10.0FT BOREHOLE WAS LOGGED BY EBERLINE ANALYTICAL CORPORATION
6"Ø HSA											
ST 3"	24"	24"	100%						ST1	13.5 FT BLACK OXIDE STAINING NOTED.	11.5FT SHELBY TUBE
SS 2"	18"	18"	14	4	6	8		15	3		
6"Ø HSA											
SS 2"	18"	18"	16	5	6	10	616.2	19.5	4	19.5 FT GRAVELLY.	
6"Ø HSA								20		19.5 TO 44.8 FT GRAVEL AND CLAY (GC): YELLOW ORANGE(10YR 6/6) TO MOD. REDDISH BROWN(10R 4/6). STIFF. MEDIUM TO HIGH PLASTICITY. MOTTLED. BLACK OXIDE STAINING. GRAVELS OF LIGHT GRAY(N8) TO BLUISH WHITE (5B 9/1) LIMESTONE AND CHERT. LOCALLY INTERBEDS OF SILT AT 28 - 30 FT.	
SS 2"	18"	18"	15	4	7	8		25	5		
6"Ø HSA											
SS 2"	18"	18"	14	5	6	8		30	6		32.7 FT: AUGER REFUSAL RESIDUUM
6"Ø HSA										FROM 32.7 FT FRAGMENTS OF VUGGY LIMESTONE AND CHERT MIXED WITH REDDISH BROWN CLAY.	32.7 TO 76.0FT CORE WITH NXB WIRE LINE DIAMOND IMPREGNATED CORE BIT USING WATER.
NXB	3.3'	.85'	26%				600.7	35	RUN #1		

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENNISON; P=PITCHER; O=OTHER
HSA=HOLLOW STEM AUGER

SITE	HOLE NO.
NORTH END OF ASH POND DAM	GMW-5

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	2 of 3	GMW-5

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS OR PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
NXB CORE							600.7	35			32.7 TO 41 FT: DRILLING FAST AND SLOW. CIRC. LOSS @ 42 FT PERFORMED PACKER TEST 38.8-44.7 FT UNABLE TO TAKE TESTS LOWER IN HOLE EVEN AFTER REAMING. BLOCKAGE AT ~45FT BURLINGTON/KEOKUK FM.
	5.0'	0'	0%	13.8	10	10		40	RUN #2	41 FT FRAGMENTS OF BROWN GRAY(5YR 4/1) LIMESTONE AND CHERT. VUGGY.	
	5.0'	1.6'	32%	15.5	20	5	590.9	44.8	RUN #3		
				13.1	10	5		45			
	1.7'	1.2'	71%						4	44.8 TO 66.9 FT LIMESTONE, LIGHT BROWNISH GRAY(5YR 4/1). MODERATELY TO SEVERELY WEATHERED. CLOSELY TO MODERATELY FRACTURED. FRACTURES GENERALLY 10° TO 30°, IRON STAIN ON FRACTURE SURFACES. CHERT LAYERS AND LENSES PRESENT. SLIGHTLY WEATHERED AND VERY HARD. VUGS, LOCALLY. 47.7 - 48.2 FT VUGS 61.0 - 62.0 FT VUGS	
	3.3'	2.65'	80%					50	RUN #5		
	5.0'	4.85'	97%					55	RUN #6		
	5.0'	4.9'	98%					60	RUN #7	63.6 FT A 1/8" THICK GREEN (5GY 3/2) SILTY CLAY SEAM (@ ~ 5°) 63.6 - 64.6 FT LIMESTONE, WHITISH GRAY (N7), SLIGHTLY WEATHERED.	
	5.0'	4.8'	96%					65	RUN #8		
	5.0'	4.7'	94%				568.8	66.9	RUN #9	66.9 TO 76.0 FT LIMESTONE AND CHERT WHITISH GRAY(N7). SLIGHTLY WEATHERED. HARD. LOCAL LENSES AND INTERBEDS OF LIGHT GRAY(N7) CHERT 0.2 TO 0.4' THICK. STYLOLITES CAN BE OBSERVED. MODERATELY FRACTURED.	
	5.0'	4.9'	98%				560.7	70 75	RUN #10		

RUN	AP (FT)	LP (FT)	RQD (%)
1	<0.1	.2	0
2	0	0	0
3	<.1	.2	0
4	0.2	.6	40
5	0.1	.5	
6	0.4	1.1	
7	0.3	.6	
8	0.3	.8	68
9	0.3	.7	71
10	0.2	.8	53

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER

SITE	HOLE NO.
NORTH END OF ASH POND DAM	GMW-5

BECHTEL

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	3 of 3	GMW-5

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS OF PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							560.7	75				
NXB							559.7	76			BOTTOM OF BORING AT 76.0 FT. REAMED TO 8-1/2 INCH AND INSTALLED 2-INCH 316L STAINLESS STEEL MONITORING WELL SCREENED FROM 65.5 TO 75.5 FT.	AP=AVERAGE LENGTH OF CORE FOR EACH RUN. LP=LONGEST PIECE OF CORE FOR EACH RUN. RQD=ROCK QUALITY DESIGNATION. COLOR CODES FROM <u>ROCK COLOR CHART</u>, GEOLOGICAL SOCIETY OF AMERICA, 1948.

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER

SITE	HOLE NO.
NORTH END OF ASH POND DAM	GMW-5

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	1 of 2	GMW-6

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
WEST OF FROG POND	N101,223 W49,852	90	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
6/26/86	7/21/86	GEOTECHNOLOGY KURT JAEGER	CME-45	6"/3"	22.6	42.9	65.5FT

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
41.31/96.3	5	5	635.8	633.8	30.1/603.7	22.6FT/611.2

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 LBS/30 IN	2"/68.5'	J.E. KAISER

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS or PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M. / 1ST 6"	PRESSURE P.S.I. / 2ND 6"	TIME IN MINUTES / 3RD 6"	ELEVATION	DEPTH	SAMPLE
							633.8	0	
6"Ø HSA							633.3	0.5	
SS 2"	18"	2"	17	5	9	8			1
6"Ø HSA								5	
SS 2"	18"	13"	26	6	11	15			2
HSA								10	
ST 3"	24"	23"	96%						ST1
SS 2"	18"	5"	27	11	6	21	619.8	14	3
6"Ø HSA								15	
SS 2"	18"	11"	17	8	5	12			4
6"Ø HSA								20	
NXB CORE	3.35'	2.85'	85%				611.2	22.6	RUN#1
	4.5'	4.5'	100%					25	RUN#2
	.5'	.41'	82%					30	RUN#3
	5.0'	4.9'	98%				598.8	35	RUN#4

DESCRIPTION AND CLASSIFICATION

0.0-0.5 FT GRAVEL AND CLAY(GC), LIGHT BROWN (5YR 6/4) TO YELLOW BROWN (10YR 5/4). SILTY CLAY WITH ANGULAR FRAGMENTS OF LIMESTONE AND CHERT. LOW PLASTICITY. DRY TO MOIST.

0.5 FT SILTY CLAY(CL). YELLOWISH BROWN.(10YR 5/4) TO YELLOWISH ORANGE (10YR 6/6). STIFF. MEDIUM PLASTICITY. MOIST. MOTTLED. TRACE LMST. GRAVEL AND NODULES. TRACE FINE SAND.

14.0-22.6 FT GRAVELLY CLAY(GC): YELLOWISH ORANGE (10YR 6/6). STIFF. MEDIUM PLASTICITY. MOIST. ANGULAR FRAGMENTS OF LIMESTONE AND CHERT. LIMESTONE FRAGMENTS OCCASIONALLY HIGHLY WEATHERED TO POWDERY CONSISTENCY.

22.6-58.1 FT LIMESTONE. LIGHT BROWNISH GRAY (5YR 4/1) TO YELLOWISH BROWN (10YR 5/4). MODERATELY TO SEVERELY WEATHERED MEDIUM HARD TO HARD. CLOSELY FRACTURED. SOME FRACTURES WITH OXIDE STAINING ALONG FRACTURES. CHERT LAYERS AND LENSES. VUGGY. VUGS AT: 32.6'; 33.1'; 33.6'

RUN#3

NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.

0-22.6 FT DRILLED WITH 6 - IN OD HOLLOW STEM AUGERS USING CENTER PLUG

0-10.0 FT BOREHOLE WAS RADIOLOGICALLY LOGGED BY EBERLINE ANALYTICAL CORPORATION

11.5 FT TOOK SHELBY TUBE SAMPLE

22.6 FT AUGER REFUSAL

22.6 FT PERFORMED INTERFACE PERMEABILITY TEST BURLINGTON/ KEOKUK FM

RUN #1
RQD = 28%
AP = 0.2 FT
LP = 0.4 FT

RUN #2
RQD = 78%
AP = 0.4 FT
LP = 1.0 FT

RUN #3
RQD = 0 %
AP = 0.1 FT
LP = 0.2 FT

RUN #4
RQD = 54%
AP = 0.2 FT
LP = 0.7 FT

▽ 6/27/86

22.6-65.5FT CORED WITH NXB WIRE-LINE DIAMOND IMPREGNATED BIT USING WATER

LOST CIRC. 25.0FT

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER

SITE	HOLE NO.
WEST OF FROG POND	GMW-6

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	2 of 2	GMW-6

Elevation 590.8 — Depth 35

Sample Type and Diameter	Sampler Advance / Length Core Run	Sample Recovery / Core Recovery	Sample Blows per 6" or Percent Core Recovery	Water Pressure Tests: Loss in G.P.M.	Pressure P.S.I.	Time in Minutes	Elevation	Depth	Sample
NXB CORE				0.05	10	5			
	5.0'	4.75	95%	0.04	20	10			RUN #5
				0.02	10	10			
	5.0'	5.0'	100%	0	10	10			RUN #6
				0.9	20	10			
				0	10	5			
	.5'	.5'	100%						7
	4.0'	4.0'	100%						RUN #8
	1.0'	1.0'	100%						9
	5.0'	4.4'	88%						RUN #10
	4.5'	4.5'	100%				575.7	58.1	RUN #11
	4.5'	4.5'	100%				568.3	65.5	RUN #12

DESCRIPTION AND CLASSIFICATION

37.2 - 38.7 FT BRECCIATED ZONE. ANGULAR CHERT AND LIMESTONE FRAGMENT IN A MEDIUM GRAY(N5) CLAY ZONE.

47.3 - 47.8 FT HIGHLY FRACTURED AND WEATHERED ZONE 47.3 TO 47.8 FT. NOTE SOME FOSSILS ON LIMESTONE FRAGMENTS.

58.1 TO 65.5 FT <u>LIMESTONE</u>, WHITISH GRAY(N8). SLIGHTLY WEATHERED. HARD. MODERATELY FRACTURED. LOCAL LENSES OR FRAGMENTS OF BROWNISH GRAY(5YR 4/1) CHERT. PRESSURE SOLUTION CRENULATIONS (STYLOLITES).

BOTTOM OF BORING AT 65.5 FT. REAMED HOLE TO 8-1/2 INCH AND INSTALLED 2-INCH 316L STAINLESS STEEL MONITORING WELL SCREENED FROM 55.5 TO 65.5 FT.

NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.

RUN	AP (FT)	LP (FT)	RQD (%)
5	0.2	0.6	40
6	0.1	0.4	14
7	0.1	0.2	0
8	0.3	0.8	62
9	0.3	0.6	85
10	0.4	0.7	70
11	0.5	1.3	71
12	0.4	0.9	69

AP=AVERAGE LENGTH OF CORE FOR EACH RUN.
LP=LONGEST PIECE OF CORE FOR EACH RUN.
RQD=ROCK QUALITY DESIGNATION.

COLOR CODES FROM <u>ROCK COLOR CHART</u>, GEOLOGICAL SOCIETY OF AMERICA, 1948.

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER

SITE	HOLE NO.
WEST OF FROG POND	GMW-6

BECHTEL

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	1 OF 3	GMW-7

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
PATROL ROAD WEST OF COAL STORAGE	N100,928 W50,933	90	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
6/27/86	7/8/86	GEOTECHNOLOGY INC.	CME 750/MOBILE B-57	6"/3"	59.0	35.0	94.0'

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
32.4/93	4	13	-	649.0	48.8'/600.2	59.0'/590.0

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 LBS/30 IN	2"/94.0'	A.ATKINSON/E.BERGLUND

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M. / 1ST 6"	PRESSURE P.S.I. / 2ND 6"	TIME IN MINUTES / 3RD 6"	SAMPLE
6" HSA							
SS 2"	18"	17"	15	5	6	9	SS-1
6" HSA							
SS 2"	18"	2"	10	4	4	6	SS-2
6" HSA							
ST 3"	24"	26"					ST-1
SS 2"	18"	18"	18	5	6	12	SS-3
6" HSA							
SS 2"	18"	19"	14	5	6	8	SS-4
6" HSA							
SS 2"	18"	22"	29	12	12	17	SS-5
6" HSA							
SS 2"	18"	23"	29	10	12	17	SS-6
6" HSA							
SS 2"	18"	26"	27	14	12	15	SS-7

ELEVATION	DEPTH	DESCRIPTION AND CLASSIFICATION
649.0	0	
648.5	0.5	0 TO 0.5 FT GRAVEL, LIGHT GRAY(N7) LIMESTONE IN BROWNISH BLACK(5YR 2/1) TO BLACK(N1) FLYASH MATRIX.
		0.5 TO 11.0 FT CLAYEY SILT, MOTTLED BROWN AND GRAY(10YR 5/4 TO 10YR 4.5/5), STIFF, OXIDIZED NODULES.
638.0	11	11.0 TO 17.0 FT CLAYEY SILT, MOTTLED TAN, BROWN, AND GRAY(10YR 5.5/6), VERY STIFF, WITH SOME FINE GRAINED SAND AND FEW ROUNDED PEBBLES, BLACK(N1) MANGANESE OXIDE FILLINGS AND STAINING.
632.0	17	17.0 TO 22.0 FT SILTY CLAY, GRAY AND TAN(10YR 5/4), SOME FINE-GRAINED SAND, MANGANESE OXIDE STAINING.
627.0	22	22.0 TO 46.0 FT CLAYEY SILT, VERY STIFF SOME FINE GRAINED SAND, OCCASIONAL ROUNDED PEBBLES, BLACK(N1) MANGANESE OXIDE STAINING AND HEALING OF FRACTURES IS COMMON. 23.5 TO 25.0 FT DARK YELLOWISH ORANGE (10YR 5.5/6). 28.5 TO 30.0 FT YELLOWISH ORANGE 10YR 5.5).
614.0	35	

NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.

0-59.0 FT DRILLED WITH 6IN OD HOLLOW STEM AUGERS USING CENTER PLUG.

0 TO 10.0 FT BOREHOLE WAS RADIOLOGICALLY LOGGED BY EBERLINE ANALYTICAL CORPORATION.

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENNISON; P=PITCHER; O=OTHER

SITE	HOLE NO.
PATROL ROAD WEST OF COAL STORAGE AREA	GMW-7

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	2 OF 3	GMW-7

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M. (1ST 6")	PRESSURE P.S.I. (2ND 6")	TIME IN MINUTES (3RD 6")	ELEVATION	DEPTH	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
6" HSA							614.0	35		38.5 TO 40.0 FT YELLOWISH BROWN (10YR 5/1), HIGHER PERCENTAGE OF CLAY.	
SS 2"	18"	24"	27	10	11	16		40	SS-8		
6" HSA										43.5 TO 45.0 FT MODERATE YELLOWISH BROWN (10YR 5/4), OCCASIONAL ROCK FRAGMENTS, VERY MOIST, DARKER BROWN (10YR 3/3) FROM 44.7 TO 45.0 FT.	
SS 2"	18"	20"	12	4	6	6		45	SS-9		
6" HSA							603.0	46		46.0 TO 59.0 FT GRAVELLY CLAY, ORANGE BROWN (10YR 5/6), AND ANGULAR, YELLOWISH WHITE (10YR 7/3) CHERT.	∇ 7/9/86
SS 2"	18"	20"	57	21	29	28		50	SS-10		
6" HSA											
SS 2"	18"	16"	30	16	16	14		55	SS-11		
6" HSA										58.5 TO 58.7 FT ROCK FRAGMENTS IN WET BROWN (10YR 4/4) MUD.	59.0 FT AUGER REFUSAL. INTERFACE PERMEABILITY TEST PERFORMED AT 59.0 FT.
SS 2"	2"	2"	50/2"	50/2"	-	-			SS-12		
6" HSA							590.0	59			
NXB 3"	5'	4.4'	88%					60	RUN #1	59.0 TO 69.0 FT LIMESTONE, YELLOWISH BROWN (10YR 5/4), MODERATELY WEATHERED SLIGHTLY HORIZONTALLY FRACTURED, WITH GRAY (N6), HARD CHERT FILLED VOIDS UP TO 4 INCHES THICK, CORE IS 30 TO 40% CHERT, SOME FRACTURES ARE CLAY FILLED.	BURLINGTON/KEOKUK FM. 59.0 TO 94.0 FT CORED WITH NXB WIRELINE DIAMOND IMPREGNATED CORE BIT USING WATER.
NXB 3"	5'	4.5'	90%	0.016 0.002	10 20	5 5		65	RUN #2		
NXB 3"	5'	4.6'	92%				580.0	69 70	RUN #3	69.0 TO 94.0 FT LIMESTONE, MEDIUM GRAY (N6) SLIGHTLY WEATHERED TO FRESH, MODERATELY HARD, SLIGHTLY FRACTURED, WITH HARD, LIGHT BLUE GRAY (5B 5/1) CHERT FILLED VOIDS, FRACTURES ARE HORIZONTAL WITH FEW CLAY FILLED, STYLOLITES.	
							574.0	75			

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENNISON; P=PITCHER; O=OTHER

SITE	HOLE NO.
PATROL ROAD WEST OF COAL STORAGE AREA	GMW-7

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	3 of 3	GMW-7

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS OR PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							574.0	75				
NXB 3"	5'	4.5'	90%							RUN #4	78.4 FT STYOLITE. 78 - 79.9 FT LIMESTONE WITH NO CHERT. 80.0 STYLOLITE.	
NXB 3"	5'	4.9'	98%					80		RUN #5	82 - 84 FT LIMESTONE BECOMES CLAYEY, SOFTER. 84 - 89 FT THIN ZONES OF CLAYEY, SOFTER LIMESTONE.	
NXB 3"	5'	4.7'	94%					85		RUN #6	89 - 94 FT FEW FRACTURES FILLED WITH ORGANIC CLAY UP TO 1/4" THICK.	
NXB 3"	5'	4.8'	96%					90		RUN #7	93.5 - 94 FT COLOR BECOMES DARK BROWN (5YR 4/6).	
							555.0	94			BOTTOM OF BORING AT 94.0 FT. REAMED HOLE TO 8-1/2 INCH AND INSTALLED 2-INCH 316L STAINLESS STEEL MONITORING WELL SCREENED FROM 83.0 TO 93.0 FT.	

RUN	AP (FT)	LP (FT)	RQD (%)
1	0.15	0.3	0
2	0.2	0.5	30
3	0.3	0.56	43
4	0.25	0.56	44
5	0.25	0.9	27
6	0.25	0.4	58
7	0.3	0.8	71

AP=AVERAGE LENGTH OF CORE PIECES FROM EACH RUN.
LP=LONGEST PIECE OF CORE FROM EACH RUN.
RQD=ROCK QUALITY DESIGNATION FOR EACH RUN.

COLOR CODES FROM ROCK COLOR CHART, GEOLOGICAL SOCIETY OF AMERICA, 1948.

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER

SITE	HOLE NO.
PATROL ROAD WEST OF COAL STORAGE AREA	GMW-7

BECHTEL

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	1 of 2	GMW-8

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
700 FT. NORTH OF COAL STORAGE	N101,720 W50,659	90	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
6/23/86	7/25/86	GEOTECHNOLOGY INC	CME-45	6"/3"	31.5	25.5	57.0'

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
23.0/90	3	7	-	619.9	34.2'/585.7	31.5'/588.4

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 LBS/30 IN	2"/58.5'	A.ATKINSON

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS per 6" / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							619.9	0			
HSA-6"							619.7	0.2		0 TO 0.2 FT ASPHALT 0.2 TO 7.0 FT SILTY CLAY, MOTTLED BROWN-TAN-YELLOW-GRAY(5Y 4/4), STIFF.	0-31.5 FT DRILLED WITH 6IN OD HOLLOW STEM AUGERS WITH CENTER PLUG.
SS 2"	18"	4"	12	6	5	7		5	SS-1		
HSA							612.9	7		7.0 TO 17.0 FT CLAYEY SILT, MOTTLED ORANGE(10YR 4/6) AND GRAY(5Y 7/1), SOME FINE-GRAINED SAND AND GRAVEL, BLACK(N1) MANGANESE OXIDE NODULES AND STAINING.	
SS 2"	18"	13"	29	5	12	17		10	SS-2		0 TO 10.0 FT BORE-HOLE WAS RADIOLOGICALLY LOGGED BY EBERLINE ANALYTICAL CORPORATION.
HSA											
ST	12"	12"	100%						ST 1	12.5 FT BECOMING LIGHT BROWN(5YR 4/4) TO ORANGE(10YR 5/6) WITH ANGULAR CHERT GRAVEL.	
SS 2"	15"	11.5"	91/9"	21	41	50/3"			SS 3		
HSA								15			
							602.9	17		17.0 TO 31.5 FT GRAVELLY CLAY, MODERATE REDDISH BROWN(10R 4/6) TO MODERATE BROWN(5YR 3/4), WITH YELLOWISH ORANGE (10YR 7/6) TO WHITE(N9) ANGULAR CHERT GRAVEL.	
SS 2"	5"	4"	50/5"	50/5"					4		
HSA								20			
SS 2"	18"	15"	20	11	9	11		25	SS-5		
HSA											31.5 FT PERFORMED PERMEABILITY TEST THROUGH AUGERS. PUMPED 5 GPM INTO HOLE FOR 20 MINUTES WITHOUT FILLING HOLE.
SS 2"	18"	14"	33	5	20	13		30	SS-6		
6" HSA							588.4	31.5		31.5 TO 51.3 FT LIMESTONE, BEIGE(10YR 6/4), MODERATELY WEATHERED, MODERATELY HARD TO HARD, WITH WHITISH GRAY(N8) CHERT NODULES AND PATCHES. 32.0 FT DISSOLUTION APPARENT.	31.5 FT AUGER REFUSAL. BURLINGTON/KEOKUK FM. ▽ 6/25/86
NXB 3"	4.0'	2.9'	73%				584.9	35	RUN #1		

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENNISON; P=PITCHER; O=OTHER

SITE	HOLE NO.
700 FT NORTH OF COAL STORAGE AREA	GMW-8

BECHTEL

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	2 OF 2	GMW-8

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							584.9	35			
WIRELINE CORE BARREL W/ DIAMOND BIT	2.0'	1.9'	95%	0.03	20	5			RUN #2	36.0 TO 41.9 FT INCREASE IN CHERT CONTENT.	31.5 TO 57.0 FT CORED WITH AN NXB WIRELINE DIAMOND IMPREGNATED CORE BIT USING WATER.
	1.0'	0.75'	75%	0.66	28	5			3		
	2.0'	1.1'	55%	0.20	20	5		40	RUN #4		
	1.0'	0.85'	85%						5		
	4.0'	4.0'	100%					45	RUN #6	45.4 TO 50.3 FT OCCASIONAL CALCITE FILLED VUGS.	
	5.0'	4.8'	96%	0.9	28	5			RUN #7		
				0.3	20	5		50			
	5.0'	5.0'	100%				568.6	51.3	RUN #8	51.3 TO 57.0 FT LIMESTONE, GRAY(N8), FRESH, CHERTY, CRYSTALLINE, DARK COATINGS ON FRACTURES AT 51.3 FT, 51.5 FT, AND 51.6 FT.	
	1.5'	1.5'	100%					55	9		
							562.9	57		BOTTOM OF BORING AT 57.0 FT. REAMED HOLE TO 8-1/2 INCHES AND INSTALLED 2-INCH 316L STAINLESS STEEL MONITORING WELL SCREENED FROM 45.5 TO 55.5 FT.	

RUN	AP (FT)	LP (FT)	RQD (%)
1	0.2	0.5	48
2	0.2	0.5	42
3	0.75	0.75	100
4	0.3	0.3	55
5	0.85	0.85	100
6	0.4	0.8	71
7	0.3	0.4	52
8	0.3	0.5	57
9	0.2	0.5	47

AP=AVERAGE LENGTH OF CORE PIECES FROM EACH RUN.
LP=LONGEST PIECE OF CORE FROM EACH RUN.
RQD=ROCK QUALITY DESIGNATION FOR EACH RUN.

ALL SOIL AND ROCK COLOR DESCRIPTIONS FROM THE ROCK COLOR CHART, PRINTED BY THE GEOLOGICAL SOCIETY OF AMERICA, 1948.

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENNISON; P=PITCHER; O=OTHER

SITE: 700 FT NORTH OF COAL STORAGE AREA

HOLE NO. GMW-8

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	1 of 2	GMW-9

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
300 FT NORTH OF COAL STORAGE AREA	N101,350 W50,700	90	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
6/25/86	7/16/86	GEOTECHNOLOGY INC. KURT JAEGER	CME 45/CME 750	6"/3"	20.5	33.5	54.0'

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
[illegible]2/33	2	5	-	636.7	39.0'/597.7	20.5 FT/616.2

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 LBS/30 IN	2"/61'	J.E. KAISER/E. BERGLUND

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M. (1ST 6")	PRESSURE P.S.I. (2ND 6")	TIME IN MINUTES (3RD 6")	ELEVATION	DEPTH	SAMPLE
							636.7	0	
6"ø HSA							636.2	0.5	
SS 2"	18"	11"	10	3	4	6		5	1
6"ø HSA									
SS 2"	18"	16"	23	5	10	13		10	2
6"ø HSA									
ST 3"	24"	20"	83				625.2	11.5	ST1
SS 2"	18"	18"	39	6	17	22		15	3
6"ø HSA									
SS 2"	5"	5"	50+	50/5"	-	-		20	4
NXB 3"	9'	3.3'	37%	15.4	10	5	616.2	20.5	RUN #1
				18.6	20	5	610.2	26.5	
				15.1	10	5	607.7	29	
NXB 3"	10'	2.0'	20%					30	RUN #2
							601.7	35	

DESCRIPTION AND CLASSIFICATION

0 TO 0.5 FT SILTY CLAY (CL). BLACK (N1) LOW PLASTICITY. MOIST. ORGANICS.

0.5 TO 11.5 FT SILTY CLAY: LIGHT BROWN (5YR 5/6) TO RED BROWN (10R 4/6) LOW PLASTICITY. SOFT. MOIST. MOTTLED. LOCALLY LIGHT GRAY (N7) SILTY CLAY LENSES OCCASIONAL LIMESTONE FRAGMENTS. SOME BLACK OXIDE (N1) STAINING.

10.0 FT BECOMING MORE BROWN

11.5 TO 20.5 FT GRAVELLY CLAY(GC): LIGHT REDDISH BROWN(10R 4/6) REDDISH BROWN(10R 3/4). MEDIUM TO HIGH PLASTICITY. STIFF. LOCALLY, LIMESTONE AND CHERT FRAGMENTS (ANGULAR, GENERALLY 1/2" AVG.) MOTTLED. MOIST.
15 FT BECOMING REDDISH BROWN.

20.5 TO 26.5 FT LIMESTONE, YELLOWISH ORANGE(10YR 6/6), DECOMPOSED, SOFT TO MODERATELY HARD, WIYH LIGHT GRAY(N7) HARD CHERT INTERBEDS AND NODULES, YELLOWISH ORANGE(10YR 6/6) CLAY SEAMS WITH ANGULAR CHERT GRAVEL.

26.5 TO 29.0 FT LIMESTONE, LIGHT GRAY (N6), MODERATELY WEATHERED, HORIZONTALLY FRACTURED, WITH FEW INTERBEDS OF LIGHT GRAY(N7), HARD CHERT, UP TO 3 INCHES THICK, SOME SOLUTION PITS <1/8 INCH DIAMETER.
28.4 TO 29.0 FT 90% CHERT IN CORE.

29.0 TO 54.0 FT LIMESTONE, YELLOWISH BROWN(10YR 6/4), WEATHERED TO LOCALLY DECOMPOSED, HORIZONTALLY FRACTURED, WITH LIGHT GRAY(N7), HARD CHERT INTERBEDS, FILLED VOIDS, AND NODULES.
29.0 TO 33.0 FT CORE IS 80% CHERT.

NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.

0-20.5 FT DRILLED WITH 6 IN OD HOLLOW STEM AUGERS USING CENTER PLUG.

0 TO 10.0 FT BOREHOLE WAS RADIOLOGICALLY LOGGED BY EBERLINE ANALYTICAL CORPORATION.

11.5FT: SHELBY TUBE

20.5 FT AUGER REFUSAL.
20.5 FT PERFORMED INTERFACE PERMEABILITY TEST AT 5 GPM.

BURLINGTON/KEOKUK FM.

20.5 TO 54.0 FT CORED WITH NXB WIRELINE DIAMOND IMPREGNATED CORE BIT USING WATER.

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER; HSA=HOLLOW STEM AUGER

SITE	HOLE NO.
300 FT NORTH OF COAL STORAGE AREA	GMW-9

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	2 of 2	GMW-9

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS or PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							601.7	35		33.0 TO 43.7 FT DECOMPOSED LIMESTONE WITH CLAY SEAMS.	6/26/86
NXB 3"	10'	5.3'	53%					40, 45	RUN #3	43.7 TO 44.7 FT HIGHLY WEATHERED LIMESTONE, CORE IS 70% CHERT 44.7 TO 46.5 FT LIGHT GRAY(N6), FRESH LIMESTONE. 45.7 TO 46.0 FT CORE IS 60% CHERT. 46.5 TO 49.0 FT MODERATELY WEATHERED, CORE IS 50% CHERT. 48.5 FT OPEN FRACTURE, ORIENTED 60 ° FROM HORIZONTAL, IRON STAINED.	RUN / AP (FT) / LP (FT) / RQD (%) 1 / 0.15 / 0.55 / 39 2 / 0.25 / 0.45 / 68 3 / 0.15 / 0.45 / 16 4 / <0.1 / 0.2 / 0
NXB 3"	6'	0.6'	10%					50	RUN #4	49.0 TO 54.0 FT RECOVERED ONLY PIECES OF CHERT.	
							582.7	54		BOTTOM OF BORING AT 54.0 FT. REAMED HOLE TO 8-1/2" AND INSTALLED 2 INCH 316L STAINLESS STEEL MONITORING WELL SCREENED FROM 47.6 TO 57.6 FT. AP=AVERAGE LENGTH OF CORE PIECES FROM EACH RUN. LP=LONGEST PIECE OF CORE FROM EACH RUN. RQD=ROCK QUALITY DESIGNATION FOR EACH RUN.	ALL SOIL AND ROCK COLOR DESCRIPTIONS FROM THE ROCK COLOR CHART, PRINTED BY THE GEOLOGICAL SOCIETY OF AMERICA, 1948.

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER

SITE: 300 FT. NORTH OF COAL STORAGE AREA

HOLE NO. GMW-9

BECHTEL

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	1 of 2	GMW-10

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
400 FT NORTH OF TRUCK DOCK	N101,150 W50,100	90	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
6/25/86	7/21/86	GEOTECHNOLOGY INC. KURT JAEGER	CME-45/CME 750	6"/3"	32.85	26.5	59.0'

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
18.35/72	3	7	-	642.1	40.0'/602.1	32.8'/609.3

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 LBS/30 IN	2"/61'	J.E.KAISER/E.BERGLUND

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS or PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M. / 1ST 6"	PRESSURE P.S.I. / 2ND 6"	TIME IN MINUTES / 3RD 6"	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							642.1	0				
6"⌀ HSA							641.6	0.5			0 - 0.5 FT GRAVEL AND CLAY LIGHT BROWN (5YR 5/6) SILTY CLAY WITH FINE TO COARSE LIMESTONE GRAVEL. CLAY IS MOD. STIFF, LOW PLASTICITY AND MOIST. GRAVEL MOD. WEA., HARD AND ANGULAR.	0-32.8 FT DRILLED WITH 6IN OD HOLLOW STEM AUGERS USING CENTER PLUG.
SS 2"	18"	16"	17	3	7	10				1	0.5 TO 18.8 FT SILTY CLAY LT. REDDISH BROWN (10R 4/6). STIFF, MEDIUM PLASTICITY MOIST. MOTTLED (LT GRAY AND RED) LOCALLY WITH SAND SIZE LIMESTONE FRAGMENTS. LOCAL BLACK OXIDE STAIN. ALSO CHERT. 5 FT BECOMING MORE REDDISH.	
6"⌀ HSA								5				0 TO 10.0 FT BORE HOLE WAS RADIOLOGICALLY LOGGED BY EBERLINE ANALYTICAL CORPORATION
SS 2"	18"	18"	20	4	9	11				2		
6"⌀ HSA								10				
ST 3"	24"	20"	83							ST 1		
SS 2"	18"	18"	26	7	11	15				3		
6"⌀ HSA								15			18.5 TO 18.75 FT LT. GRAY CLAY INTERBED.	
SS 2"	18"	18"	19	13	8	11	623.3	18.8		4	18.8 TO 32.8 FT SILTY CLAY DARK REDDISH BROWN (10R 3/4), MEDIUM PLASTICITY, STIFF MOIST, MOTTLED.	RESIDUUM 32.8 FT AUGER REFUSAL. PULLED BACK AUGER TO 32.5 FT AND PERFORMED INTERFACE PERMEABILITY TEST AT 5 GPM.
6"⌀ HSA								20				
SS 2"	18"	10"	54	14	35	19				5	23.5 TO 25.0 FT NUMEROUS FRAGMENTS OF LIMESTONE AND CHERT.	
6"⌀ HSA								25				32.8 TO 59.0 FT CORED USING NXB WIRELINE DIAMOND IMPREGNATED CORE BIT AND FRESH WATER.
SS 2"	18"	12"	26	8	11	15	612.6	29.5		6	29.5 TO 32.8 FT LIMESTONE, YELLOWISH BROWN (10YR 5/4), HIGHLY WEATHERED TO DECOMPOSED, HIGHLY FRACTURED, WITH FRACTURES FILLED WITH DARK REDDISH BROWN (10R 3/4?) CLAY.	
6"⌀ HSA								30				BURLINGTON/KEOKUK FM.
							609.3	32.8			32.8 TO 59.0 FT LIMESTONE, MODERATE YELLOWISH BROWN (10YR 5/4), MODERATELY WEATHERED, MODERATELY HARD, HORIZONTALLY	
							607.1	35				

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER

SITE	HOLE NO.
400 FT NORTH OF TRUCK DOCK	GMW-10

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	2 of 2	GMW-10

Sample type and diameter	Sampler advance / length core run	Sample recovery / core recovery	Sample blows / percent core recovery	Loss in G.P.M.	Pressure P.S.I.	Time in minutes	Elevation	Depth	Sample	Description and classification	Notes on water levels, water return, character of drilling, etc.
							607.1	35			
NXB 3"	7'	4.8'	69%						RUN #1	FRACTURED, WITH LIGHT GRAY(N7) TO MEDIUM GRAY(N5), HARD CHERT INTERBEDS FILLED VOIDS, NODULES. FEW OPEN SOLUTION FEATURES, FRACTURES FILLED WITH DARK YELLOWISH ORANGE(6YR 6/6) CLAY WITH LITTLE SAND. 32.8 TO 39.0 FT 80% OF CORE IS CHERT. 39.0 TO 49.0 FT 40% OF CORE IS CHERT, FEW FRACTURES ARE IRON STAINED.	▽ 6/27/86
NXB 3"	10'	7.2'	72%	13.1 15.2 12.2	10 20 10	5 5 5		40 45	RUN #2		
NXB 3"	10'	7.35'	74%					50 55	RUN #3	49.0 TO 59.0 FT SLIGHTLY MORE FRACTURES, SOME FILLED WITH UP TO 1-INCH CLAY SEAMS, CORE IS 40% CHERT, FEW FOSSILS NOTED IN CORE.	
							583.1	59		BOTTOM OF BORING AT 59.0 FT. REAMED HOLE TO 8-1/2 INCH AND INSTALLED 2-INCH 316L STAINLESS STEEL MONITORING WELL SCREENED FROM 48.0 TO 58.0 FT.	

RUN	AP (FT)	LP (FT)	RQD (%)
1	0.25	<.1	55
2	0.5	0.25	18
3	0.5	0.15	30

AP=AVERAGE LENGTH OF CORE PIECES FROM EACH RUN.
LP=LONGEST PIECE OF CORE FROM EACH RUN.
RQD=ROCK QUALITY DESIGNATION FOR EACH RUN.

ALL SOIL AND ROCK COLOR DESCRIPTIONS FROM THE ROCK COLOR CHART, PRINTED BY THE GEOLOGICAL SOCIETY OF AMERICA, 1948.

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER

SITE	HOLE NO.
400 FT NORTH OF TRUCK DOCK	GMW-10

BECHTEL

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	1 of 2	GMW-11

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
50 FT NORTH OF TRUCK DOCK	N100,916 W50,030	90	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
6/26/86	7/18/86	GEOTECHNOLOGY INC.	MOBIL B-57/CME 750	6"/3"	32.0	42.0	74.0'

CORE RECOVERY(FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
37.7/90	5	7	-	653.0	52.0'/601.0	32.0'/621.0

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 LBS/30 IN	2"/76'	A.ATKINSON/E.BERGLUND

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS % PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M. 1ST 6"	PRESSURE P.S.I. 2ND 6"	TIME IN MINUTES 3RD 6"	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							653.0	0				
6" HSA											0 TO 6.0 FT CLAYEY SILT, MOTTLED BROWN AND GRAY(10YR 4.5/3) WITH BLACK STAINING.	0-32.0 FT DRILLED WITH 6IN OD HOLLOW STEM AUGERS USING CENTER PLUG.
SS 2"	18"	15"	12	6	6	6		5		SS-1		
6" HSA							647.0	6			6.0 TO 27.0 FT SILTY CLAY, MOTTLED GRAY, BROWN, AND ORANGE, STIFF TO VERY STIFF, MOIST, BLACK MANGANESE STAINING COMMON, OCCASIONAL ROUNDED PEBBLES AND SAND GRAINS, NODULES OF IRON OXIDE COMMON BELOW 23.0 FT.	0 TO 10.0 FT BOREHOLE WAS RADIOLOGICALLY LOGGED BY EBERLINE ANALYTICAL CORPORATION
SS 2"	18"	17"	14	5	6	8		10		SS-2	8.5 TO 10.0 FT(10YR 5/4)	
6" HSA												
ST 3"	24"	26"						15		ST-1	15.5 TO 16.0 FT(10YR 5/6)	
SS 2"	18"	19"	19	6	8	11				SS-3	16.0 TO 17.0 FT(5Y 5/1)	
6" HSA												
SS 2"	18"	19"	20	7	8	12		20		SS-4	18.5 TO 20.0 FT(10YR 5/6)	
6" HSA												
SS 2"	18"	24"	22	9	10	12		25		SS-5	23.5 TO 25.0 FT(10YR 5.5/5)	32.0 FT AUGER REFUSAL, PERFORMED INTERFACE PERMEABILITY TEST.
6" HSA							626.0	27			27.0 TO 32.0 FT GRAVELLY CLAY, WHITISH (10YR 8/2), ANGULAR CHERT GRAVEL IN MATRIX OF ORANGE-BROWN(10YR 5/5) SILTY CLAY WITH BLACK(N1) MANGANESE OXIDE STAINING COMMON.	
SS 2"	4"	5"	50/4"	50/4"	-	-				6		32.0 TO 74.0 FT CORED USING NXB WIRELINE DIAMOND IMPREGNATED BIT AND FRESH WATER.
6" HSA								30				
							621.0	32			32.0 TO 42.6 FT LIMESTONE, LIGHT GRAY(N7) TO MODERATE YELLOWISH BROWN(10YR 5/4) MODERATELY WEATHERED, HARD, MODERATELY HORIZONTALLY FRACTURED, WEATHERING	BURLINGTON/KEOKUK FM.
							618.0	35				

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER	SITE	HOLE NO.
	50 FT NORTH OF TRUCK DOCK	GMW-11

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	2 of 2	GMW-1

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	SAMPLE
NXB 3"	7'	6.6'	94%	RUN #1
NXB 3"	10'	9.1'	91%	RUN #2
NXB 3"	9'	7.5'	83%	RUN #3
NXB 3"	9'	7.5'	83%	RUN #4
NXB 3"	7'	7.0'	100%	RUN #5

WATER PRESSURE TESTS

LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES
19.2	10	5
21.2	20	5
18.4	10	5

ELEVATION	DEPTH
618.0	35
610.4	42.6
583.7	69.3
579.0	74

DESCRIPTION AND CLASSIFICATION

INCREASES WITH DEPTH, WITH LIGHT GRAY(N7), HARD CHERT INTERBEDS AND FILLED VOIDS UP TO 3-INCHES IN DIAMETER. FRACTURES ARE FILLED WITH YELLOWISH ORANGE(10YR 7/6) CLAY.

34.0 TO 35.0 FT CLAY SEAM.

35.0 3-INCH LAYER OF DECOMPOSED LIMESTONE.

36.0 3-INCH LAYER OF DECOMPOSED LIMESTONE.

39.0 TO 42.6 FT 80% OF CORE IS CHERT FILLED VOIDS.

42.6 TO 69.3 FT LIMESTONE, YELLOWISH BROWN(10YR 5/4), SLIGHTLY WEATHERED, HARD, HORIZONTALLY FRACTURED, WITH OCCASIONAL LAYERS OF LIGHT GRAY(N7) CHERT NODULES MAKE-UP 20% OF CORE, OCCASIONAL VUGS (UP TO 3/4 INCH), FEW FOSSILS.

46.3 TO 58.0 FT 50 TO 70% OF CORE IS CHERT.

69.3 TO 74.0 FT LIMESTONE, OLIVE GRAY (5Y 6/1) SLIGHTLY WEATHERED, HARD, HORIZONTALLY FRACTURED, WITH MEDIUM BLUE GRAY(5B 6/1), HARD CHERT FILLED VOIDS, 60% OF CORE IS CHERT.

70.7 FT HORIZONTAL FRACTURE SURFACE COATED WITH BLACK(N1) ORGANIC MATERIAL.

BOTTOM OF BORING AT 74.0 FT. REAMED HOLE TO 8-1/2 INCH AND INSTALLED 2-INCH 316L STAINLESS STEEL MONITORING WELL SCREENED FROM 62.8 TO 72.8 FT.

NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.

RUN	AP (FT)	LP (FT)	RQD (%)
1	0.95	0.35	52
2	1.2	0.35	51
3	0.7	0.25	49
4	0.5	0.25	23
5	0.45	0.2	33

▽ 6/30/86

AP=AVERAGE LENGTH OF CORE PIECES FROM EACH RUN.
LP=LONGEST CORE PIECE FROM EACH RUN.
RQD=ROCK QUALITY DESIGNATION FOR EACH RUN.

SOIL AND ROCK COLOR DESCRIPTIONS FROM THE ROCK COLOR CHART, PRINTED BY THE GEOLOGICAL SOCIETY OF AMERICA, 1948.

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER

SITE: 50 FT NORTH OF TRUCK DOCK

HOLE NO.: GMW-1

BECHTEL

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	1 of 2	GMW-12

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
SOUTH OF FROG POND	N101,050 W49,643	90	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
6/26/86	7/17/86	GEOTECHNOLOGY INC.	MOBIL B-57/CME 750	6"/3"	25.5	34.5	60.0'

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
32.15/93	4	6	-	636.2	26.09/610.11	25.5'/610.7

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 LBS/30 IN	2"/61.0'	A.ATKINSON/E.BERGLUND

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS PER 6" / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M. (1ST 6")	PRESSURE P.S.I. (2ND 6")	TIME IN MINUTES (3RD 6")	SAMPLE
6" HSA							
SS 2"	18"	15"	10	3	5	5	SS-1
6" HSA							
SS 2"	18"	16"	12	5	6	6	SS-2
ST 3"	18"	16"					ST-1
6" HSA							
SS 2"	18"	17"	37	4	6	31	SS-3
6" HSA							
SS 2"	18"	16"	8	6	4	4	SS-4
6" HSA							
SS2"	4"	4"	50/4"	50/4"	-	-	5
6" HSA							
NXB 3"	3.5'	3.2'	91%				RUN #1
NXB 3"	5'	3.6'	72%				RUN #2

ELEVATION	DEPTH	DESCRIPTION AND CLASSIFICATION
636.2	0	0 TO 6.0 FT CLAYEY SILT, BROWN (10YR 4/2), MEDIUM STIFF, MOIST.
630.2	6	6.0 TO 20.0 FT SILTY CLAY, MOTTLED BROWN-ORANGE-GRAY(10YR 5/6), MEDIUM STIFF TO HARD, MOIST, OCCASIONAL BLACK (N1) MANGANESE OXIDE FILLINGS, SAND SIZE ROCK FRAGMENTS, IRON OXIDE NODULES. 13.5 TO 14.7 FT(10YR 4.5/3). 14.7 TO 15.0 FT WHITE(N9) ANGULAR CHERT FRAGMENT. 18.5 TO 20.0 FT(10YR 5/5) OCCASIONAL DECOMPOSED CHERT FRAGMENTS.
616.2	20	20.0 TO 25.5 FT GRAVELLY CLAY, BROWN (10YR 4/3), HARD, WITH WHITE(N9) ANGULAR CHERT FRAGMENTS.
610.7	25.5	25.5 TO 50.5 FT LIMESTONE, DUSKY YELLOW (5Y 6/4) TO MEDIUM LIGHT GRAY(N6), MODERATELY WEATHERED, MEDIUM HARD, HORIZONTALLY FRACTURED, WITH HARD, MEDIUM LIGHT GRAY(N6) CHERT INTERBEDS AND FILLED VOIDS. FEW SOLUTION CAVITIES AND VUGS, SOME CONTAINING CLAY FILLING FRACTURE FREQUENCY DECREASES WITH DEPTH WITH SOME FRACTURE SURFACES COATED WITH CLAY. 25.9 TO 29.0 FT CORE IS 40% CHERT. 33.0 TO 33.5 FT 6-INCH DIAMETER VOID. 34.0 TO 35.0 FT OPEN CAVITY, COATED WITH CLAY.
601.2	35	

NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.

0-25.5 FT DRILLED WITH 6IN OD HOLLOW STEM AUGERS USING CENTER PLUG.

0 TO 10.0 FT BORE HOLE WAS RADIOLOGICALLY LOGGED BY EBERLINE ANALYTICAL CORPORATION.

25.5 FT AUGER REFUSAL, PERFORMED INTERFACE PERMEABILITY TEST.

BURLINGTON/KEOKUK FM.

▽ 7/18/86

25.5 TO 60.0 FT CORED USING NXB WIRELINE DIAMOND IMPREGNATED CORE BIT AND FRESH WATER.

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENNISON; P=PITCHER; O=OTHER

SITE	HOLE NO.
SOUTH OF FROG POND	GMW-12

GEOLOGIC DRILL LOG

BECHTEL

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	2 OF 2	GMW-12

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS PER 6" / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	SAMPLE	DESCRIPTION AND CLASSIFICATION
							601.2	35		
NXB 3"	5'	5.0'	100%						RUN #3	35.7 TO 37.5 FT 2-1/2 INCH DIAMETER CHERT NODULES. 37.5 TO 39.4 FT CORE IS 70% CHERT.
NXB 3"	2'	1.9'	95%					40	RUN #4	39.4 TO 45.0 FT CORE IS 20% CHERT.
NXB 3"	3'	3.0'	100%						RUN #5	
NXB 3"	1'	0.65'	65%					45	6	
NXB 3"	5'	4.9'	98%						RUN #7	47.6 TO 50.5 FT EXTREMELY WEATHERED ZONE.
							585.7	50 / 50.5		
NXB 3"	5'	4.9'	98%	.22	20	8		55	RUN #8	50.5 TO 60.0 FT LIMESTONE, MEDIUM LIGHT GRAY(N6), SLIGHTLY WEATHERED, MODERATELY HARD, SLIGHTLY FRACTURED, WITH MEDIUM BLUISH GRAY(5B 5/1) CHERT FILLED VOIDS. 53.8 TO 59.0 FT BROWNISH GRAY(5YR 5/1) EXTREMELY WEATHERED, SOFT, WITH MEDIUM BLUISH GRAY(5B 5/1) CHERT FILLED VOIDS MAKING UP 40 TO 50 % OF CORE.
NXB 3"	5'	5.0'	100%						RUN #9	
							576.2	60		BOTTOM OF BORING AT 60.0 FT. REAMED HOLE TO 8-1/2 INCH DIAMETER AND INSTALLED 2-INCH 316L STAINLESS STEEL MONITORING WELL SCREENED FROM 48.0 TO 58.0 FT.

AP=AVERAGE LENGTH OF CORE PIECES FROM EACH RUN.
LP=LONGEST PIECE OF CORE FROM EACH RUN.
RQD=ROCK QUALITY DESIGNATION FOR EACH RUN.

NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.

RUN	AP (FT)	LP (FT)	RQD (%)
1	0.2	0.5	34
2	0.3	0.7	47
3	0.25	0.5	18
4	0.25	0.45	24
5	0.20	0.35	12
6	0.15	0.3	0
7	0.15	0.4	22
8	0.3	0.6	37
9	0.25	0.5	65

ALL SOIL AND ROCK COLOR DESCRIPTIONS FROM THE ROCK COLOR CHART, PRINTED BY THE GEOLOGICAL SOCIETY OF AMERICA, 1948.

	SITE	HOLE NO.
SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENNISON; P=PITCHER; O=OTHER	SOUTH OF FROG POND	GMW-12

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	1 of 2	GMW-13

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
OUTSIDE OF FENCE NE OF BLDG. 404	N100,819 W49,539	90	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
6/26/86	7/16/86	GEOTECHNOLOGY INC.	MOBL B-57	6"/3"	27.5	42.5	70.0'

CORE RECOVERY(FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
40.3/95	5	6	-	645.5	39.6'/605.9	27.5'/618.0

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 LBS/30 IN	2"/69.0'	A.ATKINSON/D.HARNISH

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS 6" OR PERCENT CORE RECOVERY	WATER PRESSURE TESTS: 1ST 6" (LOSS IN G.P.M.)	2ND 6" (PRESSURE P.S.I.)	3RD 6" (TIME IN MINUTES)	ELEVATION	DEPTH	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							645.5	0		0 TO 8.6 FT CLAYEY SILT, MOTTLED TAN AND GRAY(10YR 4/4), VERY SOFT.	0-27.5 FT DRILLED WITH 6IN OD HOLLOW STEM AUGERS USING CENTER PLUG.
6" HSA											
SS 2"	18"	5"	3	3	1	2			SS-1		
6" HSA								5			
SS 2"	18"	14"	13	5	6	7	636.9	8.6	SS-2	8.6 TO 17.0 FT CLAYEY SILT, MOTTLED STIFF, COMMON DARK REDDISH BROWN (10R 3/4) IRON NODULES. 8.6 TO 10.0 FT DARK GREENISH GRAY (5GY 3/1) TO OLIVE BROWN(5Y 3.5/6)	0 TO 10.0 FT BOREHOLE WAS RADIOLOGICALLY LOGGED BY EBERLINE ANALYTICAL CORPORATION.
6" HSA								10			
ST 3"	24"	19"							ST-1		
SS 2"	18"	21.5"	14	5	7	7			SS-3	13.5 TO 15.0 FT YELLOWISH GRAY(5Y 8/1)	
6" HSA								15			
							628.5	17		17.0 TO 21.0 FT SILTY CLAY, MOTTLED, VERY STIFF, WITH WHITE(N9) SAND SIZED CHERT FRAGMENTS, OCCASIONAL BLACK(N1) MANGANESE OXIDE STAINING AND FILLINGS. 18.5 TO 20.0 FT MOTTLED ORANGE(10YR 5/6) AND LIGHT OLIVE GRAY(5Y 6/1).	
SS 2"	18"	20"	16	4	7	9		20	SS-4		
6" HSA							624.5	21		21.0 TO 27.5 FT GRAVELLY CLAY, MOTTLED YELLOWISH GRAY(5Y 8/1) AND DARK YELLOWISH ORANGE(10YR 6/6), VERY STIFF, ANGULAR WHITE(N9) AND MODERATE YELLOWISH BROWN(10YR 5/4) CHERT FRAGMENTS, TRACE TO SOME SAND.	
SS 2"	18"	11"	27	12	9	18			SS-5		27.5 FT AUGER REFUSAL. BURLINGTON/KEOKUK FM.
6" HSA								25			
NXB 3"	2.5'	2.2'	88%				618.0	27.5	RUN #1	27.5 TO 60.0 FT LIMESTONE, PALE YELLOWISH BROWN(10YR 6/2) TO LIGHT OLIVE GRAY(5Y 6/2), MODERATELY WEATHERED, MODERATELY HARD, MICRITIC, VARIABLY FOSSILIFEROUS, STYLOLITIC, ABUNDANT CHERT AS NODULES AND REPLACEMENT BEDS, RANGING IN COLOR FROM VERY LIGHT GRAY (N8) TO WHITE(N9), HARD.	27.5 TO 70.0 FT CORED USING NXB WIRELINE DIAMOND IMPREGNATED CORE BIT AND FRESH WATER.
NXB 3"	5.0'	4.6'	92%					30	RUN #2		
							610.5	35			

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER

SITE	HOLE NO.
OUTSIDE OF FENCE, NE OF BLDG.404	GMW-13

GEOLOGIC DRILL LOG

PROJECT: FUSRAP - WELDON SPRING SITE | JOB NO.: 14501-201 | SHEET NO.: 2 OF 2 | HOLE NO.: GMW-13

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS % / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	SAMPLE	DESCRIPTION AND CLASSIFICATION
							610.5	35		
NXB 3"	5.0'	4.8'	96%						RUN #3	
NXB 3"	5.0'	4.4'	88%	0.07 0.10	20 30	5 5		40	RUN #4	40.0 TO 48.5 FT CORE IS 50% CHERT.
NXB 3"	5.0'	4.8'	96%					45	RUN #5	
NXB 3"	1.1'	1.1'	100%					50	6	49.0 TO 55.0 FT YELLOWISH ORANGE (10YR 7/6), 30 TO 40% OF CORE IS CHERT.
NXB 3"	4.0'	3.6'	90%						RUN #7	
NXB 3"	5.0'	4.8'	96%					55	RUN #8	55.0 TO 60.0 FT CORE IS 50 TO 60% CHERT.
NXB 3"	5.0'	5.0'	100%				585.5	60	RUN #9	60.0 TO 70.0 FT LIMESTONE, LIGHT OLIVE BROWN(5Y 5/6), SLIGHTLY WEATHERED, MEDIUM HARD, FOSSILIFEROUS ZONES, ABUNDANT SMALL VUGS (2 TO 5MM), OPEN 1/2INCH VUG LINED WITH CALCITE, STYLOLITIC, INTERBEDDED WITH MEDIUM BLUISH GRAY(5B 5/1), HARD, CHERT.
NXB 3"	5.0'	5.0'	100%	0.07 0.08	20 30	7 5		65	RUN #10	
							575.5	70		BOTTOM OF BORING AT 70.0 FT. REAMED HOLE TO 8-1/2 INCH AND INSTALLED 2-INCH TYPE 316L STAINLESS STEEL MONITORING WELL SCREENED FROM 58.0 TO 68.0 FT.

NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.

▽ 7/3/86

RUN	AP (FT)	LP (FT)	RQD (%)
1	0.1	0.5	29
2	0.2	1.1	47
3	0.3	1.1	55
4	0.4	0.8	50
5	0.2	0.8	30
6	0.3	0.5	12
7	0.2	0.7	13
8	0.3	0.5	60
9	0.5	1.9	84
10	0.3	0.6	72

AP=AVERAGE LENGTH OF CORE PIECES FROM EACH RUN.
LP=LONGEST CORE PIECE FROM EACH RUN.
RQD=ROCK QUALITY DESIGNATION FOR EACH RUN.

SOIL AND ROCK COLOR DESCRIPTIONS FROM THE ROCK COLOR CHART, PRINTED BY THE GEOLOGICAL SOCIETY OF AMERICA, 1948.

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENNISON; P=PITCHER; O=OTHER

SITE: OUTSIDE OF FENCE, NE OF BLDG. 404 | HOLE NO.: GMW-13

BECHTEL

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	1 of 2	GMW-14

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
NE CORNER OF N PARKING LOT	N 100,735 W 49,186	90	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
6/27/86	7/7/86	GEOTECHNOLOGY INC.	MOBIL B-57/CME750	6"/3"	33.0	26.0	59.0

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
19.7/76	3	7	-	647.3	43.0'/604.3	33.0/614.3

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 LBS/30 IN	2"/59.0'	A. ATKINSON/ E. BERGLUND

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS or PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M. / 1ST 6"	PRESSURE P.S.I. / 2ND 6"	TIME IN MINUTES / 3RD 6"	SAMPLE
6"HSA							
SS 2"	18"	11"	25	4	15	10	SS-1
6"HSA							
SS 2"	18"	14"	7	3	3	4	SS-2
6" HSA							
ST 3"	12"	13"					ST-1
SS 2"	18"	13"	26	15	9	17	SS-3
6"HSA							
SS2"	9"	9.5"	50/3"	10	50/3"	-	4
6"HSA							
SS2"	4"	6"	50/4"	50/4"	-	-	5
6"HSA							
SS 2"	18"	13"	22	16	10	12	SS-6
6"HSA							
NXB 3"	2'	0.8'	40%				RUN #1

ELEVATION	DEPTH	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
647.3	0		
646.8	0.5	0 TO 0 FT CLAYEY SILT, BLACK(N1), WITH ROOTS AND OTHER ORGANIC MATERIAL.	0-33.0 FT DRILLED WITH 6IN OD HOLLOW STEM AUGERS USING CENTER PLUG.
		0.5 TO 10.5 FT CLAYEY SILT, MOTTLED GRAY AND BROWN(10YR 4.5/3), MEDIUM STIFF, SMALL IRON OXIDE NODULES, OCCASSIONAL ANGULAR ROCK FRAGMENTS.	
636.8	10.5	10.5 TO 21.0 FT SILTY CLAY, MOTTLED GREENISH GRAY(5GY 6/1) AND DARK YELLOWISH ORANGE(10YR 5/6), SOME SAND SIZED PARTICLES, AND BLACK(N1) MANGANESE OXIDE STRINGERS AND FILLINGS.	0 TO 10.0 FT BOREHOLE WAS RADIOLOGICALLY LOGGED BY EBERLINE ANALYTICAL CORPORATION.
		56.0 TO 59.0 FT FEW THIN ZONES OF DECOMPOSED LIMESTONE.	
626.3	21	21.0 TO 33.0 FT GRAVELLY CLAY, DARK YELLOWISH ORANGE(10YR 5/6), VERY STIFF EXTREMELY WEATHERED, ANGULAR, VERY PALE ORANGE(10YR 8/6) CHERT FRAGMENTS RANGING FROM PEBBLE TO SAND SIZE.	RESIDUUM
			33.0 FT AUGER REFUSAL, PERFORMED INTERFACE PERMEABILITY TEST.
614.3	33	33.0 TO 35.0 FT LIMESTONE, DARK YELLOWISH ORANGE(10YR 5/6), DECOMPOSED, MEDIUM HARD TO MEDIUM SOFT, CLAY SEAMS, CHERT INTERBEDS.	BURLINGTON/KEOKUK FM.
612.3	35		

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER

SITE	HOLE NO.
NORTHEAST CORNER OF NORTH PARKING LOT	GMW-14

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	2 of 2	GMW-14

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS or PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN GPM	WATER PRESSURE TESTS: PRESSURE P.S.I	WATER PRESSURE TESTS: TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
NXB 3"	5'	3.3'	66%				612.3	35		RUN # 2	35.0 TO FT LIMESTONE, MODERATE YELLOWISH BROWN (10YR5/4), MODERATELY TO SLIGHTLY WEATHERED, MEDIUM HARD, SLIGHTLY FRACTURED, WITH HARD, LIGHT GRAY (N7) CHERT FILLED VOIDS, HORIZONTAL FRACTURES CONTAIN CLAY FILLING.	33.0 TO 59.0 FT. CORED USING NXB WIRELINE DIAMOND IMPREGNATED CORE BIT WITH FRESH WATER.
NXB 3"	5'	3.5'	70%					40		RUN # 3	36.0 TO 38.0 FT CLAY SEAM. 40.0 TO 45.0 FT CORE IS 60% CHERT. 44.0 FT VUGS WITH QUARTZ AND CALCITE CRYSTALS.	7/7/86
NXB 3"	5'	3.5'	70%	3.5 3.75 2.7	10 20 10	8 5 5		45		RUN # 4	45.0 TO 49.0 FT FEW THIN ZONES WITH DECOMPOSED LIMESTONE AND ANGULAR CHERT FRAGMENTS. 49.0 TO 50.0 FT MEDIUM LIGHT GRAY (N6) DECOMPOSED LIMESTONE WITH FRACTURED CHERT.	
NXB 3"	5'	4.6'	92%					50		RUN # 5	50.0 TO 55.0 FT MODERATELY FRACTURED WITH CLAY FILLING, CORE IS 30% CHERT.	
NXB 3"	4'	4.0'	100%					55		RUN # 6	56.0 TO 59.0 FT FEW THIN ZONES OF DECOMPOSED LIMESTONE.	
							588.3	59			BOTTOM OF BORING AT 59.0 FT. REAMED HOLE TO 8-1/2 INCH AND INSTALLED 2-INCH 316L STAINLESS STEEL MONITORING WELL SCREENED FROM 48.0 TO 58.0 FT. AP=AVERAGE LENGTH OF CORE PIECES FROM EACH RUN. LP=LONGEST PIECE OF CORE FROM EACH RUN RQD= ROCK QUALITY DESIGNATION FOR EACH RUN.	SOIL AND ROCK COLOR DESCRIPTION FROM THE ROCK COLOR CHART, PRINTED BY THE GEOLOGICAL SOCIETY OF AMERICA, 1948.

RUN	AP (FT)	LP (FT)	RQD (%)
1	0.1	0.15	0
2	0.3	0.8	58
3	0.2	0.55	37
4	0.2	0.35	30
5	0.2	0.35	0
6	0.2	0.4	40

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER	SITE	HOLE NO.
	NORTHEAST CORNER OF NORTH PARKING LOT	GMW-14

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	1 OF 3	GMW-15

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
ACROSS INTERSECTION FROM BLDG. 412	N100,100 W50,550	90	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
6/27/86	6/30/86	GEOTECHNOLOGY INC. KURT JAEGER	CME-45	6"/3"	45.5	40.0	80.5'

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
33.1/75.2	4	8	-	657.4	53.4'/603.99	45.5'/611.9

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 LBS/30 IN	2"/78.5'	J.E.KAISER

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS or PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M. / 1ST 6"	PRESSURE P.S.I. / 2ND 6"	TIME IN MINUTES / 3RD 6"	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							657.4	0				
6"Ø HSA							656.9	0.5			0.0 TO 0.5 FT GRAVEL AND CLAY(GC). BLACK (N1) TO BROWNISH BLACK(5YR 2/1). SILTY CLAY WITH ANGULAR FRAGMENTS OF LIMESTONE AND CHERT. ORGANICS.	0-36.5 FT DRILLED WITH 6IN OD HOLLOW STEM AUGERS USING CENTER PLUG.
SS 2"	18"	2"	6	4	3	3				1	0.5 TO 33.9 FT SILTY CLAY(CL). YELLOWISH ORANGE(10YR 6/6) MEDIUM PLASTICITY. STIFF. MOTTLED(WITH MEDIUM GRAY CLAY(N7) CONTRIBUTING TO MOTTLING. TRACE LIMESTONE/CHERT FRAGMENTS AND LIMESTONE NODULES(SAND SIZE). LOCALLY BLACK OXIDE STAINS OR DEPOSITS.	
6"Ø HSA								5				
SS 2"	18"	14"	12	3	5	7				2		0 TO 10.0 FT BOREHOLE WAS RADIOLOGICALLY LOGGED BY EBERLINE ANALYTICAL CORPORATION.
6"Ø HSA								10				
ST	24"	23"	96							ST1		
SS 2"	18"	16"	14	4	6	8				3		
6"Ø HSA								15				
SS 2"	18"	N.R.	13	3	5	8				4		
SS 2"	18"	18"	5-7-10 17	5	7	10		20		4a	20.0 FT CLAY BECOMING STIFFER.	
6"Ø HSA												
SS 2"	18"	18"	24	5	10	14				5		
6"Ø HSA								25				
SS 2"	18"	18"	31	10	17	14				6	28.0 TO 30.0 FT SILT INTERBEDED, MOTTLED LOW PLASTICITY.	
6"Ø HSA								30				
SS 2"	5"	5"	50+	50/5"			623.5	33.9		7	33.9 TO 45.5 FT GRAVEL AND CLAY(GC): YELLOWISH ORANGE(10YR 6/6). SOFT, LOW TO MEDIUM PLASTICITY. WET, CONTAINS	
							622.4	35				

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER	SITE	HOLE NO.
	ACROSS INTERSECTION FROM BLDG. 412	GMW-15

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	2 of 3	GMW-15

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	SAMPLE
6" HSA							622.4	35	
NXB CORE	4.0'	1.8'	45%						RUN #1
	4.0'	NR	NR					40	RUN #2
	1.5'	0.5'	30%				611.9	45 / 45.5	3
	5.0'	3.4'	67%						RUN #4
	5.0'	4.5'	90%	17.9	10	5		50	RUN #5
				19.8	20	5			
				17.9	10	7			
	5.0'	5.0'	100%					55	RUN #6
	2.0'	2.0'	100%					60	7
	2.5'	1.3'	52%	0	10	5			8
				0.96	20	5		65	
	5.0'	4.8'	96%	0.42	10	5			RUN #9
	5.0'	5.0'	100%				587.0	70 / 70.4	RUN #10
							582.4	75	

DESCRIPTION AND CLASSIFICATION

ANGULAR FRAGMENTS OF LIGHT GRAY(N8) LIMESTONE AND CHERT.

45.5 TO 70.4 FT LIMESTONE LIGHT BROWNISH GRAY(5YR 4/1) TO YELLOWISH ORANGE (10YR 5/4). MOD. TO SEVERELY WEATHERED MED. HARD TO HARD. CLOSELY TO MOD. FRACTURED WITH FRACTURES 10° TO 30° FROM HORIZONTAL. BOTH BLACK AND RUST COLORED STAINING ALONG SOME FRACTURES. CHERT LAYERS AND LENSES.
51.0 TO 51.9 FT CHERT WITH VUGS.
54.2 TO 54.3 CHERT WITH VUGS.
DISTINCTIVE CHERT INTERBEDS:
54.0 TO 54.3 FT.
54.7 TO 54.9 FT.
68.2 TO 70.5 FT.

70.4 TO 80.5 FT LIMESTONE. WHITISH GRAY(N8). SLIGHTLY WEATHERED. HARD. MODERATELY FRACTURED. WITH LENSES AND INTERBEDS OF BROWNISH GRAY(5YR 4/1)

NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.

36.5 FT AUGER REFUSAL, PULLED AUGER BACK TO 35.5 FT AND RAN INTERFACE PERMEABILITY TEST

36.5 TO 80.5 FT CORED USING NXB WIRELINE DIAMOND IMPREGNATED CORE BIT WITH FRESH WATER.
44.5 FT CIRCULATION FLUCTUATING.
BURLINGTON/KEOKUK FM.
46.0 FT TOTAL LOSS OF CIRCULATION.

▽ 8/1/86

RUN	AP (FT)	LP (FT)	RQD (%)
1	<0.1	0.1	0
2	0	0	0
3	<0.1	0.2	30
4	0.2	0.6	67
5	0.3	1.0	53
6	0.3	0.4	83
7	0.3	0.5	96
8	<0.1	0.3	0
9	0.2	0.5	96
10	0.3	0.6	60

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER

SITE	HOLE NO.
ACROSS INTERSECTION FROM BLDG. 412	GMW-15

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	3 of 3	GMW-15

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							582.4	75				
NXB CORE	5.0'	4.8'	96							RUN #11	CHERT PRESSURE SOLUTION CRENULATIONS (STYLOLITES). VUG @ 73.3 FT. 80 TO 80.3 FT SILT INTERBED.	RUN 11, AP (FT) 0.4, LP (FT) 1.1, RQD (%) 70
								80.5			BOTTOM OF BORING AT 80.5 FT. REAMED HOLE TO 8-1/2 INCH AND INSTALLED 2-INC 316L STAINLESS STEEL MONITORING WELL SCREENED FROM 67.5 TO 77.5 FT.	
											AP=AVERAGE LENGTH OF CORE PIECES FROM EACH RUN. LP=LONGEST PIECE OF CORE FROM EACH RUN. RQD=ROCK QUALITY DESIGNATION FOR EACH RUN.	ALL SOIL AND ROCK COLOR DESCRIPTIONS FROM THE <u>ROCK COLOR CHART</u>, PRINTED BY THE GEOLOGICAL SOCIETY OF AMERICA, 1948.

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENNISON; P=PITCHER; O=OTHER

SITE	HOLE NO.
ACROSS INTERSECTION FROM BLDG. 410	GMW-15

GEOLOGIC DRILL LOG

PROJECT: FUSRAP - WELDON SPRING SITE		JOB NO.: 14501-201	SHEET NO.: 1 of 2	HOLE NO.: G-10/GMW-17
SITE: MAIN ENTRANCE GATE	COORDINATES: N100,200 W49,050		ANGLE FROM HORIZ.: 90	BEARING: -
BEGUN: 6/17/86	COMPLETED: 7/5/86	DRILLER: GEOTECHNOLOGY INC. K.JAEGER/G.MATTHEWS	DRILL MAKE AND MODEL: CME-45/CME-750	HOLE SIZE: 6-1/4"/3"
OVERBURDEN (FT.): 23.5	ROCK (FT.): 40.5	TOTAL DEPTH: 64.0'	CORE RECOVERY (FT./%): 34/84	CORE BOXES: 4
SAMPLES: 4	EL. TOP OF CASING: -	GROUND EL.: 657.8	DEPTH/EL. GROUND WATER: 52.3'/605.5	DEPTH/EL. TOP OF ROCK: 23.5'/634.3
SAMPLE HAMMER WEIGHT/FALL: 140 LBS/30 IN	CASING LEFT IN HOLE: DIA./LENGTH: 2" / 64.0'	LOGGED BY: LAWRENCE YOUNG/E. BERGLUND		

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS % PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M. / 1ST 6"	PRESSURE P.S.I. / 2ND 6"	TIME IN MINUTES / 3RD 6"	ELEVATION	DEPTH	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							657.8	0		0 TO 15.5 FT SILTY CLAY, MODERATE YELLOWISH BROWN (10YR5/4) TO BROWNISH GRAY (5YR4/1), MOTTLED WITH MEDIUM LIGHT GRAY (N6) SILT LENSES, MOIST, VERY STIFF, OXIDIZED ZONES.	0-23.5 FT DRILLED WITH 6¼IN OD HOLLOW STEM AUGERS WITH CENTER PLUG.
SS 2"	18"	16"	16	4	6	10			1		
								5			
SS 2"	18"	14"	16	3	7	9			2		
								10			0 TO 10FT BOREHOLE WAS RADIOLOGICALLY LOGGED BY EBERLINE ANALYTICAL CORP.
SS 2"	18"	22"	18	6	7	11		15	3		
							642.3	15.5		15.5 TO 23.5 FT SILTY CLAY, MODERATE BROWN (5YR4/4), MOIST, VERY STIFF, SOME SUBROUNDED FINE GRAVEL, PYROLUSITE STRINGERS.	
SS 2"	18"	18"	24	5	11	13			4		
								20			23.5 FT AUGER REFUSAL, ATTEMPTED INTERFACE PERMEABILITY TEST, WATER LEAKED AROUND OUTSIDE OF AUGERS.
NXB 3"	1'	0.35'	35%				634.3	23.5	RUN #1	23.5 TO 44.1 FT LIMESTONE, MEDIUM LIGHT GRAY (N6), SLIGHTLY TO MODERATELY WEATHERED, MODERATELY FRACTURED (APPROXIMATELY HORIZONTAL), AND CLAY FILLED WITH LIGHT GRAY (N7), HARD, CHERT INTERBEDS, FILLED VOIDS, AND NODULES, SOME ZONES OF DUSKY YELLOW (5Y6/4), EXTREMELY WEATHERED TO DECOMPOSED LIMESTONE, FEW STYLOLITES, FEW VUGS UP TO .5 INCH IN DIAMETER.	BURLINGTON/KEOKUK FM.
NXB 3"	9'	5.0'	56%	17.1 18.6 16.0	10 20 10	5 5 5		25 30	RUN #2	28.5 TO 30.5 FT. CLAY SEAM. 31.0 TO 34.0 FT. EXTREMELY WEATHERED DUSKY YELLOW (5Y6/4) LIMESTONE WITH SOME CHERT NODULES.	23.0 TO 64.0 FT CORED USING NXB WIRELINE DIAMOND IMPREGNATED CORE BIT WITH FRESH WATER. 23.5 FT GEOLOGIC BOREHOLE G-10 WAS CONVERTED TO MONITORING WELL GMW-17.
							622.8	35		35.0 FT. 6-INCH VERTICAL FRACTURE.	

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER

SITE: MAIN ENTRANCE GATE

HOLE NO.: G-10/GMW-17

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	2 of 2	G-10/GMW-17

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS 6" / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							622.8	35			
NXB 3"	5'	5.0'	100%						RUN #3	33.0 TO 38.0 FT FEW SMALL VUGS, 1/8 TO 1/4-INCH IN DIAMETER, FILLED WITH SOFT CALCITE. 38.0TO 44.0 FT FEW CAVITIES UP TO 1-1/2 INCH DIAMETER FILLED WITH CHERT. 41.5 TO 42.3 FT THREE,2-INCH THICK BEDS OF EXTREMELY WEATHERED LIMESTONE, WITH NUMEROUS CHERT FILLED VOIDS. 42.3 TO 42.8 FT DECOMPOSED, DUSKY YELLOW(5Y 6/4) LIMESTONE.	
NXB 3"	6'	5.9'	98%					40	RUN #4		
							613.7	44.1			
NXB 3"	8'	6.3'	79%					45	RUN #5	44.1 TO 61.5 FT <u>LIMESTONE</u>, DUSKY YELLOW(5Y 6/4), MODERATELY WEATHERED, MEDIUM HARD, MODERATELY HORIZONTALLY FRACTURED, NUMEROUS MEDIUM LIGHT GRAY (N6), HARD CHERT FILLED VOIDS, INTER-BEDS, AND NODULES. 52.3 TO 54.9 FT 90% OF CORE IS GRAYISH BLUE(5PB 6/2) CHERT FILLED VOIDS AND NODULES.	▽ 6/25/86
NXB 3"	7'	6.6'	94%					50 55	RUN #6		
NXB 3"	5'	4.9'	98%				596.3	60 61.5	RUN #7	61.5 TO 64.0 FT <u>LIMESTONE</u>, MEDIUM LIGHT GRAY(N6), WITH GRAYISH BLUE(5PB 5/2) CHERT NODULES UP TO 3 INCHES IN DIAMETER, SLIGHTLY WEATHERED TO FRESH, SOME HORI-ZONTAL FRACTURING, 50% OF CORE IS CHERT.	
							593.8	64		BOTTOM OF BORING AT 64.0 FT. REAMED HOLE TO 8-1/2 INCH AND INSTALLED 2-INC 316L STAINLESS STEEL MONITORING WELL SCREENED FROM 53.0 TO 63.0 FT. AP=AVERAGE LENGTH OF CORE PIECES FROM EACH RUN. LP=LONGEST PIECE OF CORE FROM EACH RUN RQD= ROCK QUALITY DESIGNATION FOR EACH RUN.	SOIL AND ROCK COLOR DESCRIPTION FROM THE <u>ROCK COLOR CHART</u>, PRINTED BY THE GEOLOGICAL SOCIETY OF AMERICA, 1948.

RUN	AP (FT)	LP (FT)	RQD (%)
1	0.05	0.2	0
2	0.15	0.45	25
3	0.25	0.6	18
4	0.2	0.45	41
5	0.25	0.8	38
6	0.25	2.5	70
7	0.25	1.3	80

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER

SITE	HOLE NO.
MAIN ENTRANCE GATE	G-10/GMW-17

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	1 of 2	GMW-1[illegible]

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
SE OF BLDG. 434	N98,297 W50,382	90	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
6/28/86	7/8/86	GEOTECHNOLOGY INC.	MOBIL B57/CME 750	6"/3"	32.5	32.5	65.0'

CORE RECOVERY(FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
18.5/59	4	7	-	661.4	39.4'/622.0	32.5/628.9

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 LBS/30 IN	2"/64.0'	A.ATKINSON/E.BERGLUND

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS 6" / PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							661.4	0				
6" HSA							660.4	1			0 TO 1.0 FT GRAVEL, LIGHT GRAY(N7), CRUSHED LIMESTONE, IN MODERATE BROWN (5YR 3/4) SILTY MATRIX. 1.0 TO 7.0 FT SILTY CLAY/CLAYEY SILT, MOTTLED TAN-BROWN-GRAY(10YR 5/4), STIFF CONTAINS SOFT, BLACK(N1), WEATHERED NODULES.	0-32.5 FT DRILLED WITH 6 IN OD HOLLOW STEM AUGERS
SS 2"	18"	15"	13	3	5	8				SS-1		
6" HSA								5				
							654.4	7			7.0 TO 11.0 FT SILTY CLAY, GREENISH GRAY(5GY 7/1) AND DARK YELLOWISH ORANGE (10YR 6/6), MEDIUM STIFF.	0 TO 10.0 FT BOREHOLE WAS RADIOLOGICALLY LOGGED BY EBERLINE ANALYTICAL CORPORATION.
SS 2"	18"	16.5"	10	3	4	6				SS-2		
6" HSA								10				
							650.4	11			11.0 TO 27.0 FT SILTY CLAY, MOTTLED ORANGE-YELLOW-BROWN(10YR 5/5), VERY STIFF, OCCASIONAL ROUNDED PEBBLES AND SAND SIZE MATERIAL, MANGANESE OXIDE STAINING AND FILLINGS COMMON.	
ST 3"	24"	26"								ST-1		
SS 2"	18"	17"	26	6	11	15				SS-3		
6" HSA								15				
SS 2"	18"	19"	18	5	8	10				SS-4		
6" HSA								20				
SS 2"	18"	27"	28	11	14	14				SS-5		32.5 FT AUGER REFUSAL, PERFORMED PERMEABILITY TEST
6" HSA								25				
							634.4	27			27.0 TO 32.5 FT GRAVELLY CLAY, MODERATE YELLOWISH BROWN(10YR 5.5/6), WITH ANGULAR CHERT GRAVEL. CHERT IS DARK YELLOWISH BROWN(10YR4.5/2) IN THE CENTER GRADING TO DARK YELLOWISH ORANGE (10YR 5.5/6) STAINED, EXTREMELY WEATHERED WITH WHITE(N9) RINDS ON GRAVEL.	BURLINGTON/KEOKUK FM.
SS 2"	18"	5"	41	8	18	23				SS-6		32.0 TO 65.0 FT CORED WITH NXB WIRELINE DIAMOND IMPREGNATED CO[illegible] BIT, USING FRE[illegible] WATER.
6" HSA								30				
NXB 3"	3'	2.2'	73%	0 0.08	10 20	5 5	628.9 626.4	32.5 35		RUN #1	32.5 TO 38.5 FT LIMESTONE, LIGHT GRAY (N7), SLIGHTLY WEATHERED, MEDIUM HARD, MODERATELY HORIZONTALLY FRACTURED, TWO FRACTURES 1/4 AND 1/2 INCH THICK FILLED.	

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER	SITE	HOLE NO.
	SOUTHEAST OF BLDG.434	GMW-18

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP - WELDON SPRING SITE	14501-201	2 of 2	GW-18

Sample type and diameter	Sampler advance / Length core run	Sample recovery / Core recovery	Sample blows or Percent core recovery	Water pressure tests: Loss in G.P.M.	Pressure P.S.I.	Time in minutes	Elevation	Depth	Sample	Description and classification	Notes on water levels, water return, character of drilling, etc.
							626.4	35			
NXB 3"	5'	3.5'	70%				622.9	38.5	RUN #2	WITH VERY LIGHT GRAY(N8) CLAY AND ANGULAR CHERT FRAGMENTS, MANGANESE OXIDE DEPOSITS ON FRACTURE SURFACES. 35.0 TO 37.3 FT LIGHT GRAY(N7) CLAY, EXTREMELY WEATHERED LIMESTONE, AND ANGULAR CHERT FRAGMENT.	7/8/86 (water level)
NXB 3"	5'	0.8'	16%					40	RUN #3	38.5 TO 57.5 FT LIMESTONE, YELLOWISH BROWN(10YR 5/4), EXTREMELY WEATHERED TO DECOMPOSED, MEDIUM HARD WITH CLAY SEAMS AND HORIZONTAL FRACTURES, CHERT INTERBEDS AND FILLED VOIDS.	
NXB 3"	5'	1.4'	28%	0.7 1.3 0.9	10 20 10	5 5 5		45	RUN #4		
NXB 3"	2'	.5'	25%					50	RUN #5		
NXB 3"	3'	1.1'	37%					55	RUN #6		
NXB 3"	5'	5.0'	100%				603.9	57.5	RUN #7	57.5 TO 65.0 FT LIMESTONE MODERATE YELLOWISH BROWN(10YR 5/4), EXTREMELY WEATHERED, MODERATELY HORIZONTALLY FRACTURED, WITH HARD, LIGHT GRAY(N7) CHERT FILLED VOIDS, SOME OF WHICH ARE INCOMPLETELY FILLED.	
NXB 3"	5'	5.0'	100%					60	RUN #8		
							596.4	65		BOTTOM OF BORING AT 65.0 FT. REAMED HOLE TO 8-1/2 INCH AND INSTALLED 2-INCH 316L STAINLESS STEEL MONITORING WELL SCREENED FROM 53.0 TO 63.0 FT.	SOIL AND ROCK COLOR DESCRIPTION FROM THE ROCK COLOR CHART, PRINTED BY THE GEOLOGICAL SOCIETY OF AMERICA, 1948.

RUN	AP (FT)	LP (FT)	RQD (%)
1	0.2	0.35	16
2	0.1	0.25	0
3	0.1	0.25	0
4	0.25	0.3	0
5	<0.1	0.1	0
6	0.2	0.35	32
7	0.15	0.35	7
8	0.2	0.35	22

AP=AVERAGE LENGTH OF CORE PIECES FROM EACH RUN.

LP=LONGEST PIECE OF CORE FROM EACH RUN

RQD= ROCK QUALITY DESIGNATION FOR EACH RUN.

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENNISON; P=PITCHER; O=OTHER

SITE	HOLE NO.
SOUTHEAST OF BLDG 434	GW-18

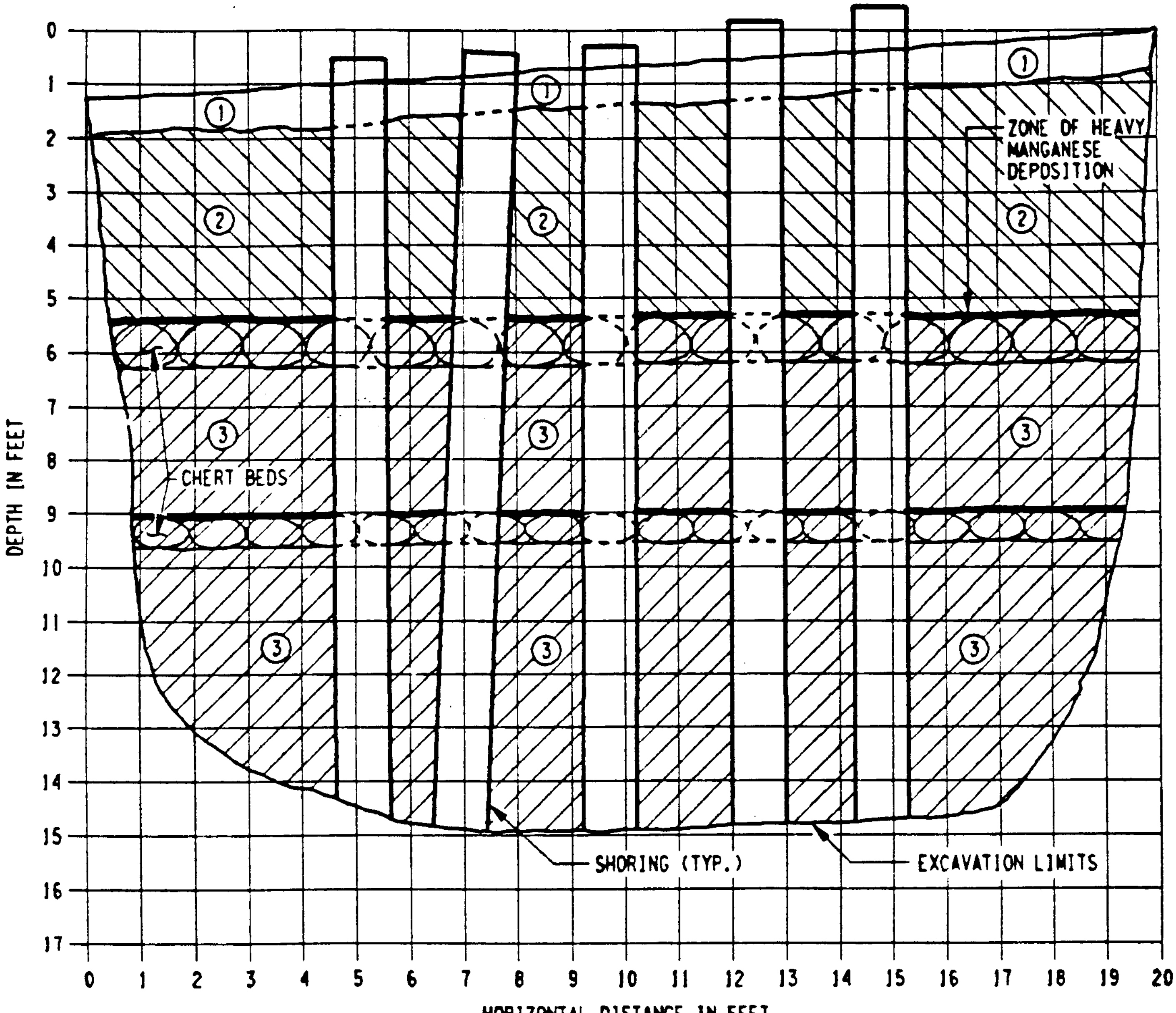
APPENDIX B
TRENCH LOGS

BECHTEL TRENCH LOG

EXCAVATION NO. T-1

PROJECT WELDON SPRING JOB NO. 14501-201 GROUND EL. 624 LOCATION N100,546.5 W52,437.5

DATE EXCAVATED 5-2-86 METHOD OF EXCAVATION BACKHOE DATE BACKFILLED 5-2-86



MATERIAL DESCRIPTIONS:

1. TOPSOIL/FILL - BROWN, SANDY, CLAYEY SILT AND GRAVEL.
2. SILT (LOESS) - MOTTLED YELLOWBROWN AND GRAY, CLAYEY SILT/SILTY CLAY, SILT DECREASES WITH DEPTH, PLASTICITY INCREASES FROM LOW TO MODERATE WITH DEPTH. DAMP. SOME VERY WEATHERED IRON NODULES UP TO 1/4"ø. FEW SCATTERED SUBROUNDED, QUARTZ AND CHERT, FINE TO MEDIUM SAND GRAINS.
3. CLAY, CHERT BEDS, AND VERY WEATHERED BLOCKS OF LIMESTONE (BURLINGTON/KEOKUK FM. RESIDUUM) - MOTTLED BRICK RED (DOMINANT COLOR), YELLOWBROWN, BROWN AND GRAY (5.0' - 9.7') AND MOTTLED YELLOWBROWN AND GRAY (9.7' - 15.0')SILTY CLAY. DAMP. LOW PLASTICITY. BLOCKY FRACTURE. LIGHT GRAY, WEATHERED WHITE ON SURFACE, HARD CHERT BEDS (~30% OF EXPOSED UNIT), 1 TO 9 INCHES THICK (2 THICKEST BEDS SHOWN), FLAT LYING. ONLY A FEW BLOCKS OF ORIGINAL LIMESTONE REMAIN. THESE ARE WHITE, SOFT, INTENSELY WEATHERED AND SHOW NO STRUCTURE, (LARGEST BLOCK WAS ~12" X 9"). CONTACT BETWEEN UNITS 2 AND 3 IS MARKED BY AN ~2" THICK ZONE OF BLOCK CLAY WITH A VERY HEAVY CONCENTRATION OF MANGANESE DEPOSITION.

SIDE WEST BEARING N1°E EXCAVATOR WEST END CONSTRUCTION CO, INC. GEOLOGIST E. BERGLUND

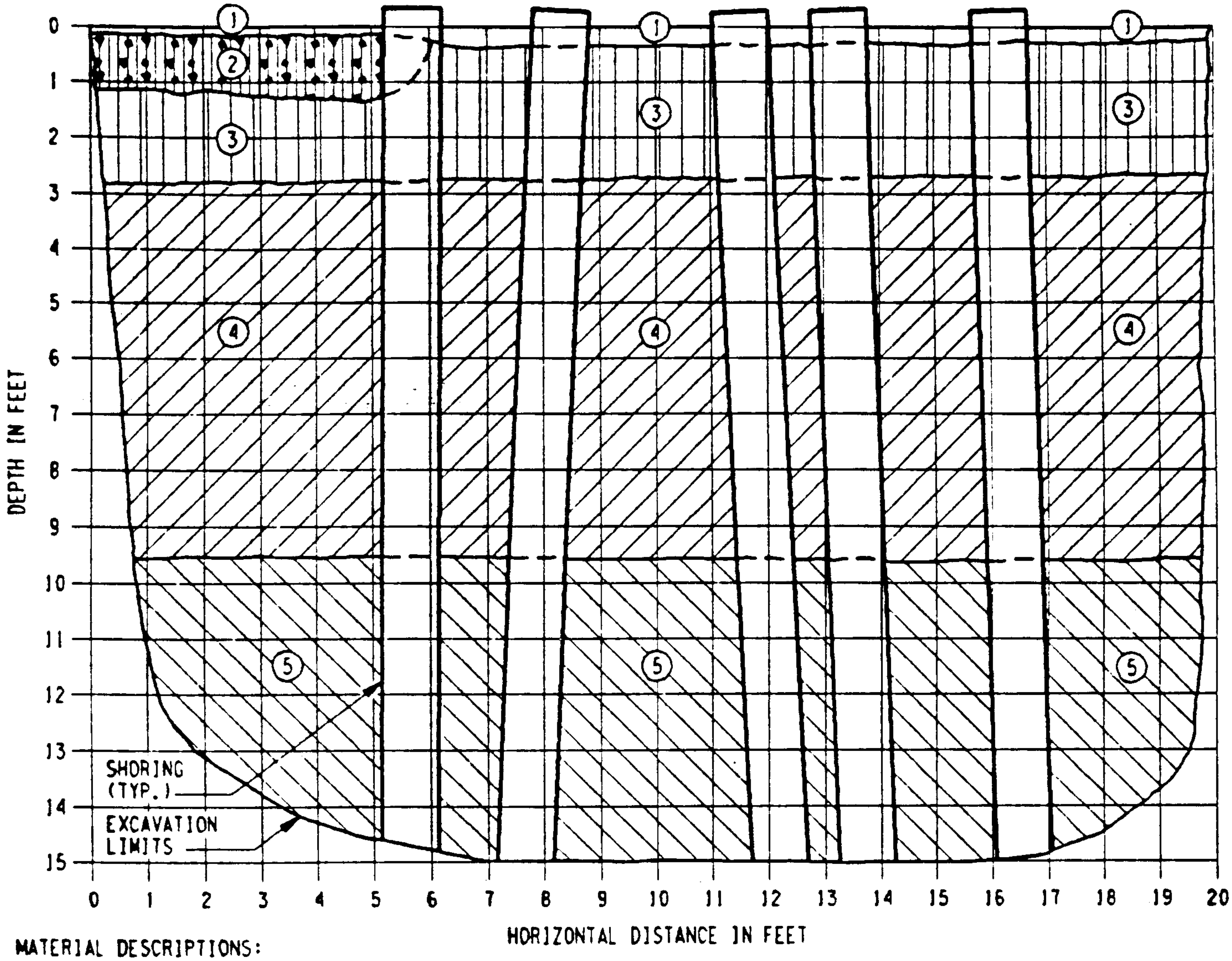
WSST1.DGN

BECHTEL TRENCH LOG

EXCAVATION NO. T-2

PROJECT WELDON SPRING JOB NO. 14501-201 GROUND EL. 657.5 LOCATION N100,555.5 W50,662.0

DATE EXCAVATED 4-30-86 METHOD OF EXCAVATION BACKHOE DATE BACKFILLED 5-1-86



MATERIAL DESCRIPTIONS:

1. TOPSOIL - BROWN CLAYEY SILT WITH SOME GRAVEL.
2. FILL - GRAY SILTY SANDY GRAVEL.
3. SILT (LOESS) - MOTTLED GRAY AND YELLOW ORANGE, SLIGHTLY CLAYEY SILT. SLIGHTLY DAMP. FRIABLE. SOME MANGANESE STAINING. NUMEROUS WEATHERED RUST BROWN IRON NODULES.
4. CLAY (FERRELVIEW FM.) - MOTTLED GRAY AND YELLOW ORANGE (LESS MOTTLED BELOW 5.7') SILTY CLAY. DAMP. CONCOIDAL FRACTURE. MODERATELY PLASTIC. FEW SCATTERED, FINE- TO MEDIUM-GRAINED, SUBROUNDED SAND GRAINS (QUARTZ AND CHERT). FEW VERY WEATHERED RUST BROWN IRON NODULES.
5. CLAY TILL - MOTTLED GRAY AND YELLOW BROWN SILTY CLAY, DAMP, MODERATELY PLASTIC, WITH SCATTERED FINE- TO MEDIUM-GRAINED, SUBROUNDED QUARTZ AND CHERT, SAND GRAINS, SUBROUNDED TO SUBANGULAR FINE TO COARSE, CHERT AND LIMESTONE GRAVEL AND SUBROUNDED COBBLES UP TO 2"X3" (CHERT AND LIMESTONE), BLOCKY FRACTURE WITH MANY FRACTURE SURFACES COATED WITH MANGANESE. NUMEROUS VERY WEATHERED, RUST BROWN, IRON NODULES UP TO 1/8"ø.

NOTE: 13.5-15.0' INTENSE MOTTLING 9.7-14.2' GRAVEL AND COBBLES 2-4%

14.2-15.0' GRAVEL AND COBBLE CONTENT INCREASES TO 20-25%

SIDE NORTH BEARING N80°W EXCAVATOR WEST END CONSTRUCTION CO., INC. GEOLOGIST E. BERGLUND

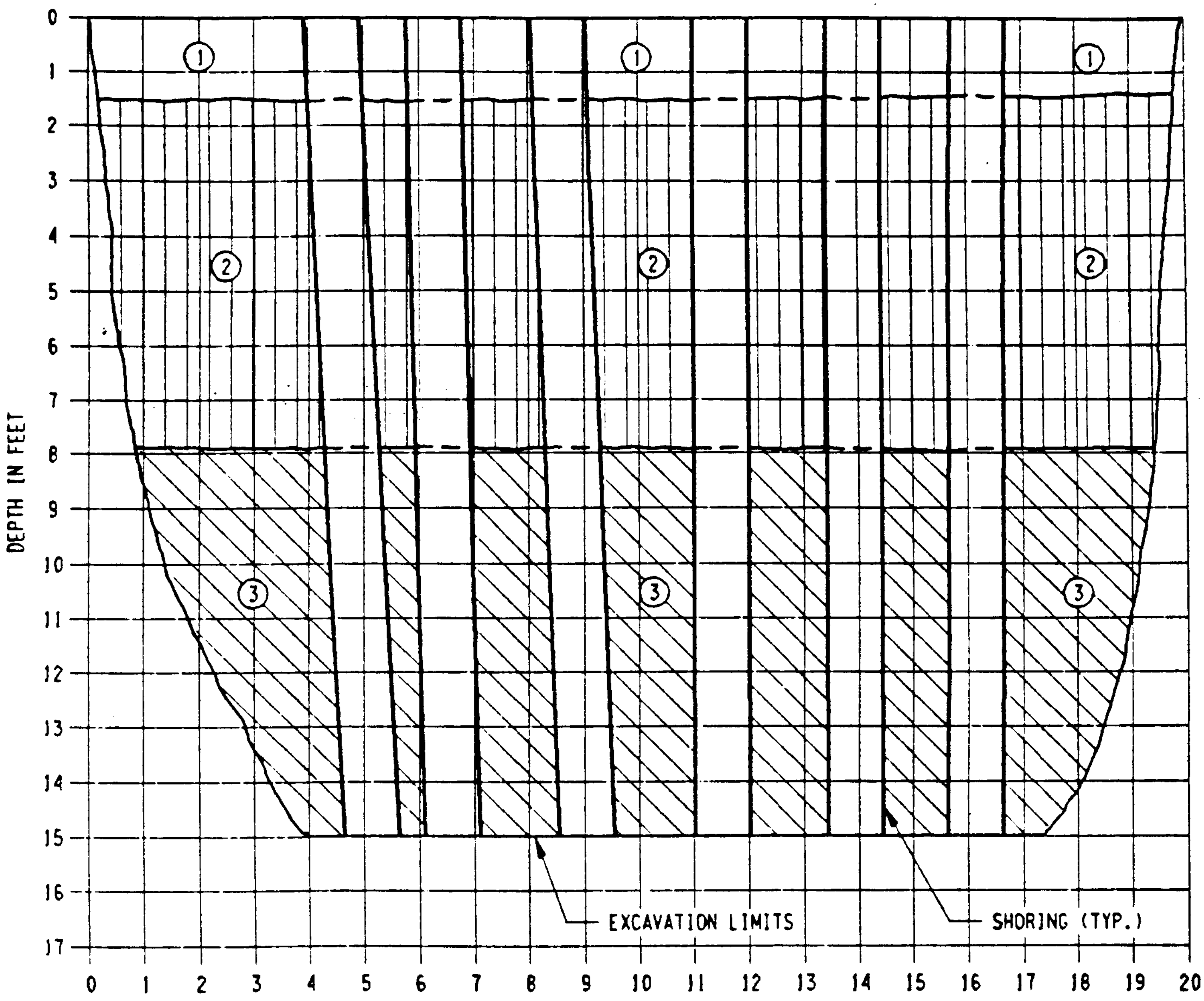
WSST2.DGN

BECHTEL TRENCH LOG

EXCAVATION NO. T-3

PROJECT WELDON SPRING JOB NO. 14501-201 GROUND EL. 665.8 LOCATION N98,621 W50,844

DATE EXCAVATED 4-29-86 METHOD OF EXCAVATION BACKHOE DATE BACKFILLED 5-1-86



MATERIAL DESCRIPTIONS:

1. FILL - BROWN, CLAYEY SILT, DRY, SOME SCATTERED GRAVEL.
2. SILT (LOESS) - MOTTLED GRAY AND YELLOW BROWN, SLIGHTLY CLAYEY (CLAY CONTENT INCREASES WITH DEPTH), SLIGHTLY DAMP, FRIABLE, MANGANESE STAINING, MANY VERY WEATHERED IRON NODULES.
3. CLAY (FERRELVIEW FORMATION) - MOTTLED MEDIUM GRAY WITH YELLOW BROWN, SLIGHTLY SILTY, DAMP, MODERATELY PLASTIC INCREASING WITH DEPTH, SCATTERED PIECES OF FINE TO MEDIUM SAND AND ANGULAR TO SUBROUNDED CHERT GRAVEL (1/2" - 2"ø). BREAKS CONCOIDALLY. FEW VERY WEATHERED IRON NODULES. MANGANESE STAINING ALONG SOME BREAKS.

SIDE EAST BEARING N20°W EXCAVATOR WEST END CONSTRUCTION CO., INC. GEOLOGIST E. BERGLUND

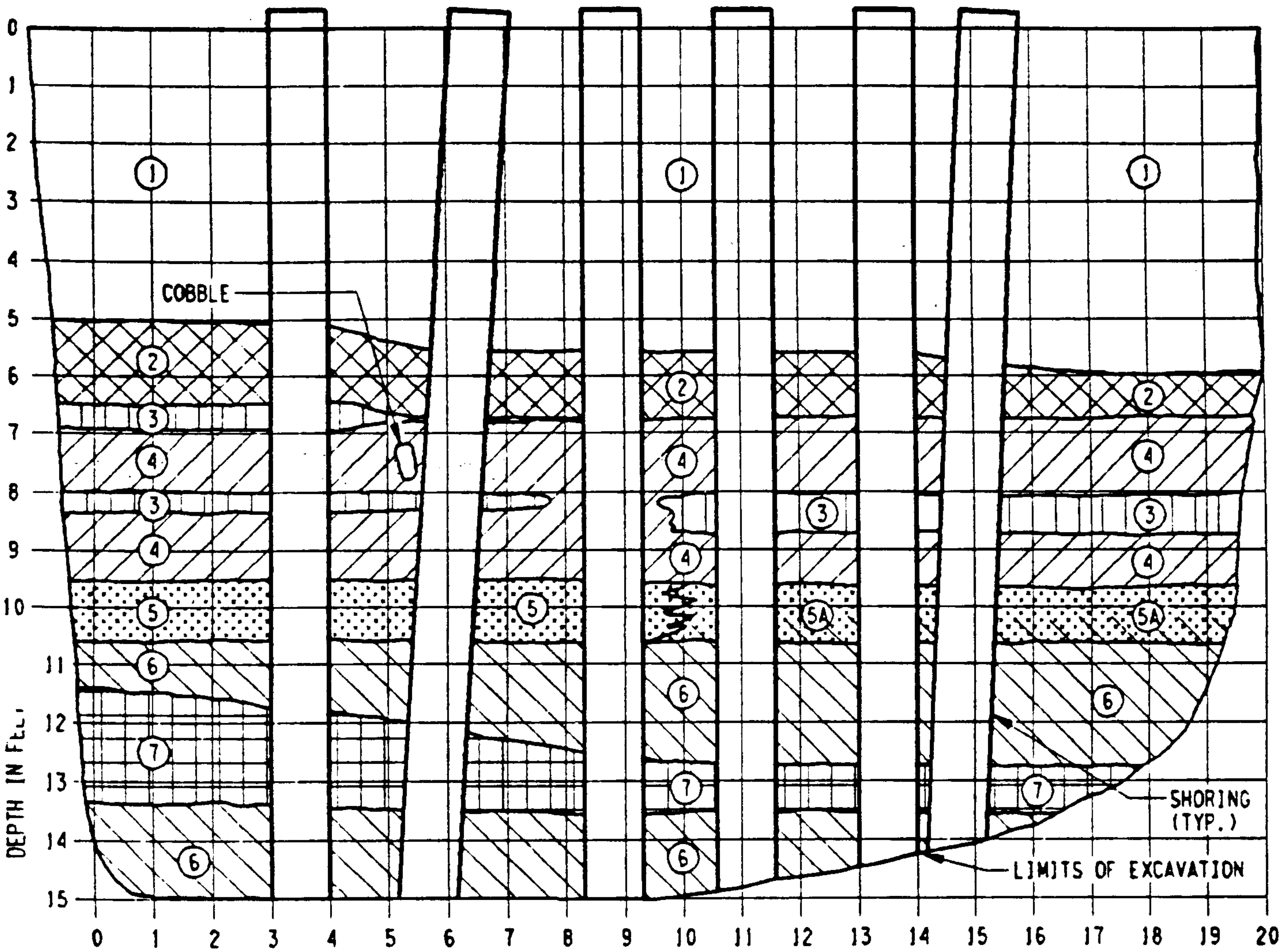
WSS13.DGN

BECHTEL TRENCH LOG

EXCAVATION NO. T-4

PROJECT WELDON SPRING JOB NO. 14501-201 GROUND EL. 657.1 LOCATION N98,886.5 W50,427

DATE EXCAVATED 4-24-86 METHOD OF EXCAVATION BACKHOE DATE BACKFILLED 4-30-86



MATERIAL DESCRIPTIONS:

FERRELVIEW FM. (units 2–7)

(1) FILL - MIXED GRAY AND YELLOWBROWN SILTY CLAY/CLAYEY SILT WITH DEBRIS (ROCK, GRAVEL, BRICK, WIRE, ASPHALT, CONCRETE, RAILROAD TIE).

(2) CLAY - MEDIUM GRAY MOTTLED WITH ORANGE BROWN, SILTY. MODERATELY PLASTIC, DAMP. FEW SCATTERED PIECES OF ANGULAR GRAVEL (3/8" - 3/4"ø). FEW VERY WEATHERED IRON NODULES (RED BROWN).

(3) SILT - DARK GRAY, SLIGHTLY CLAYEY, SLIGHTLY DAMP - CRUMBLY.

(4) CLAY - MEDIUM TO DARK GRAY. SILTY. MOIST. MANY VERY WEATHERED ORANGE-YELLOW IRON NODULES (1/8" - 1/4"ø). LITTLE ANGULAR MEDIUM SIZED GRAVEL (ONE 4" X 6" CHERT COBBLE OBSERVED). MODERATELY PLASTIC. FEW PIECES OF SCATTERED FINE TO MEDIUM SAND.

(5) SILT - MEDIUM GRAY, CLAYEY, SLIGHTLY DAMP, CRUMBLY, FEW SCATTERED PIECES OF FINE TO MEDIUM SAND.

(5A) SAME AS 5 EXCEPT GRADES INTO CLAY WITH DEPTH. (THE 5 - 6 CONTACT IS WELL DEFINED WHEREAS THE 5A - 6 CONTACT IS GRADATIONAL).

(6) CLAY - MEDIUM GRAY MOTTLED WITH YELLOW-BROWN. SLIGHTLY SILTY (MODERATELY PLASTIC) NORTH END OF TRENCH GRADING SILTIER TO SOUTH END OF TRENCH (BECOMES LESS PLASTIC). DAMP. FEW PIECEOF FINE TO MEDIUM GRAINED, ANGULAR SAND. FEW SCATTERED PIECES OF ANGULAR CHERT, GRAVEL (UP TO 3/4"ø). MANY SMALL, VERY WEATHERED, IRON-RED TO YELLOWP-ORANGE IRON NODULES (1/16" - 1/4"ø).

(7) SILT - LIGHT BLUISH GRAY TO MEDIUM GRAY. SLIGHTLY CLAYEY. WET AT NORTH END OF TRENCH TO VERY MOIST AT SOUTH END. (SLIGHT SEEPAGE INTO TRENCH FROM THIS UNIT IN NORTHERN PART OF TRENCH). INTENSE RED-BROWN IRON STAINING ALONG A BLOCKY FRACTURE FEATURE. MANY VERY WEATHERED, IRON-RED TO YELLOW-BROWN IRON NODULES (1/16" - 1/2"ø).

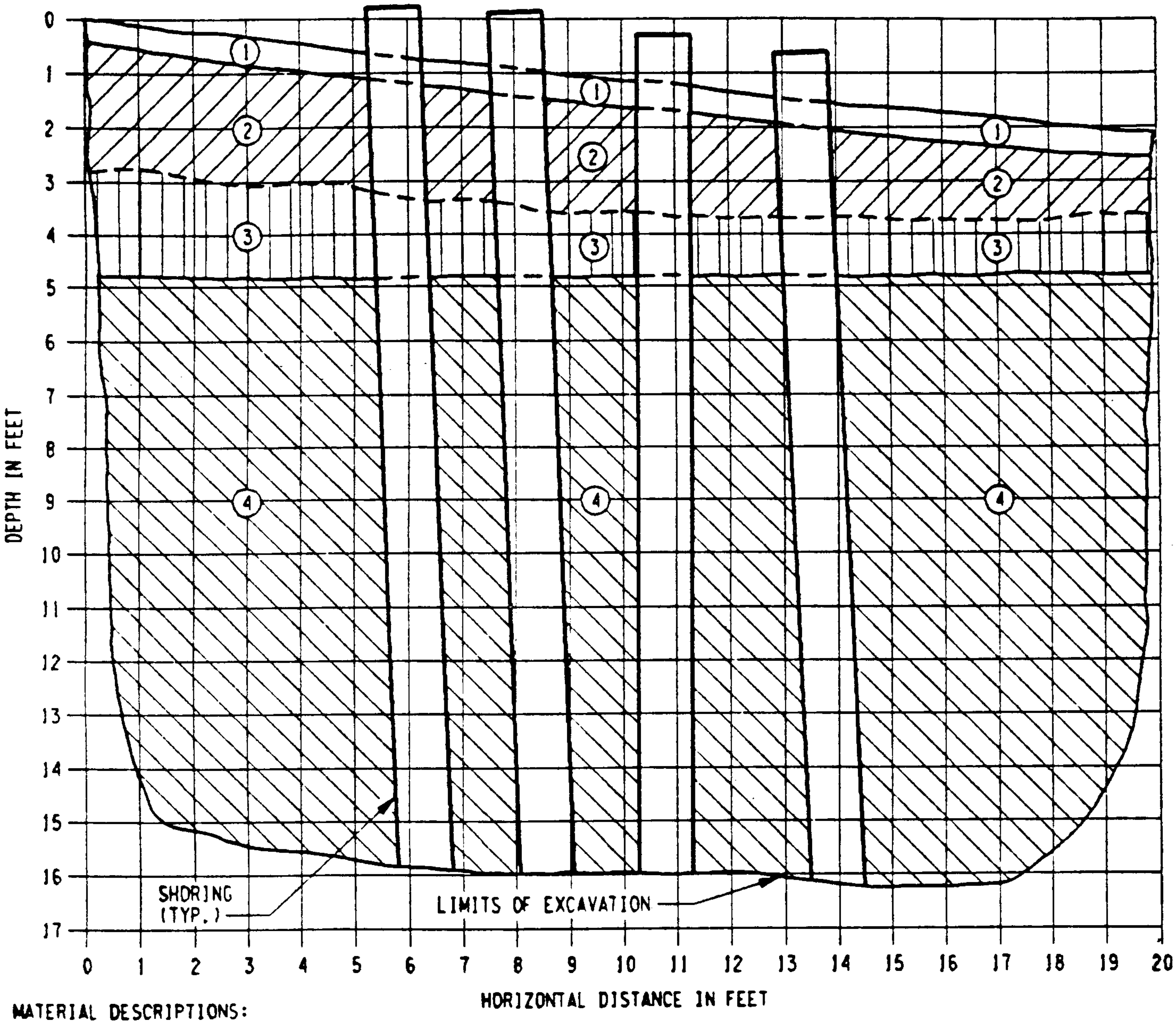
WSST4.DGN SIDE EAST BEARING N24°E EXCAVATOR WEST END CONSTRUCTION CO., INC. GEOLOGIST E. BERGLUND

BECHTEL TRENCH LOG

EXCAVATION NO. T-6

PROJECT WELDON SPRING JOB NO. 14501-201 GROUND EL. 638 LOCATION N101,206.5 W50,411.0

DATE EXCAVATED 5-1-86 METHOD OF EXCAVATION BACKHOE DATE BACKFILLED 5-2-86



MATERIAL DESCRIPTIONS:

1. TOPSOIL - BROWN, CLAYEY SILT, SLIGHTLY SANDY, SOME FINE TO MEDIUM GRAVEL. DRY.
2. FILL - MOTTLED GRAY AND YELLOW-BROWN, SLIGHTLY SILTY TO SILTY CLAY, WITH SCATTERED FINE TO MEDIUM GRAVEL AND A FEW COBBLES, SLIGHTLY DAMP.
3. CLAY (FERRELVIEW FORMATION) - MOTTLED GRAY AND YELLOW-BROWN, SILTY CLAY, FEW IRON NODULES AND RARE SAND GRAINS (QUARTZ AND CHERT). DAMP. MODERATELY PLASTIC.
4. CLAY TILL - MOTTLED YELLOW-BROWN AND GRAY, VERY SILTY CLAY, SAND CONTENT UP TO 5%, SAND SUBROUND, MEDIUM GRAINED CHERT AND QUARTZ. DAMP TO SLIGHTLY DAMP, VERY LOW PLASTICITY. BLOCKY FRACTURE WITH FRACTURE SURFACES COATED WITH MANGANESE. GRAVEL, COBBLES, AND BOULDERS MAKE UP 10 - 15%. GRAVEL IS SUBANGULAR TO SUBROUNDED, FINE TO COARSE GRAINED. COBBLES AND BOULDERS ARE SUBROUNDED AND UP TO 1 1/2'ø. GRAVEL IS CHERT AND LIMESTONE. COBBLES AND BOULDERS ARE VERY WEATHERED WHITE LIMESTONE AND GRAY CHERT WITH WHITE WEATHERED RIMS.

SIDE SOUTH BEARING N34W EXCAVATOR WEST END CONSTRUCTION CO., INC. GEOLOGIST E. BERGLUND

W5516.DGN

APPENDIX C
SEISMIC REFRACTION SURVEY REPORT

DETECTION SCIENCES, INC.

SEISMIC REFRACTION SURVEY
WELDON SPRING CHEMICAL PLANT
WELDON SPRING, MISSOURI

A Report Prepared for:

Bechtel National, Inc.
P. O. Box 350
800 Oak Ridge Turnpike
Oak Ridge, Tennessee 37830

by

Kenneth G. Blom
Principal Geophysicist, GP-887 (CA)

Detection Sciences, Inc.
921 Transport Way, Suite 5
Petaluma, California 94952
Telephone: (707) 763-1312

May 7, 1986
Job No. 86-144.01

TABLE OF CONTENTS

I SUMMARY

A seismic refraction survey was conducted at the Weldon Spring Chemical Plant, Weldon Spring, Missouri during the period February 27 through March 3, 1986. The purpose of the survey is to provide subsurface information that will aid in determining overburden thickness, the depth to and variability of the bedrock, and any anomalous conditions that are pertinent to the site characterization investigation.

The site is underlain by a sequence of unconsolidated materials overlying the Burlington/Keokuk cherty limestone formation. The overburden sequence is comprised of six stratigraphic units. The limestone is highly variable due to solutioning and other weathering and therefore has a highly irregular surface that has been referred to as pinnacled.

The results of the seismic refraction survey indicate that the subsurface can be defined by four seismic layers or units that are variable in thickness and velocity in the upper 100 to 125 feet. Generally Layers 1 and 2, with average velocities of about 1100 feet per second (fps) and 3000 fps, respectively, predominately represent the overburden but may also include weathered bedrock in the deeper sections of Layer 2. The top of Layer 3 is approximately 15 to 45 feet deep and has an average velocity of 6000 fps. Layer 3 generally represents weathered and solutioned bedrock but the shallower or upper portions of the unit could also include more compacted or saturated overburden. Layer 4 averages 12,000 fps along Profile A and 17,000 along Profile B. The depth to the top is 43 to 110 feet and represents the harder more competent and less weathered rock. The

interfaces representing the tops of Layers 3 and 4 are probably an average of the actual conditions which are believed to be highly irregular and erratic. Therefore correllations of the seismic data with borehole data describing overburden thicknesses and depth to hard rock may vary locally by 10 to 20 feet in the very irregular areas.

II INTRODUCTION

This report presents the results of a seismic refraction survey conducted by Detection Sciences, Inc. at the Weldon Spring Chemical Plant Site, Weldon Spring, Missouri. This survey was authorized under Bechtel National, Inc. Subcontract Agreement No. 14501-201-SC-176. The field work was performed during the period February 27 through March 3, 1986 by Kenneth Blom, Principal Geophysicist and Marty Clasen, Geophysical Technician, Detection Sciences, Inc. with logistical support and field assistance from Larry Young and Robert Oreweiler, Bechtel Representatives.

A. Purpose

The purpose of this survey is to provide subsurface information in regards to seismic layers, velocities, and anomalous conditions that may pertain to overburden thickness, depth and variability of bedrock and groundwater levels. This information will be used with subsequent studies for overall site characterization.

B. Scope of Work

The scope of work includes providing all the necessary personnel and seismic equipment to perform the survey, acquiring and reducing the data, and preparing the final report. The field work consisted of obtaining seismic refraction data along two (2) profiles of 2000 and 2400 lineal feet, respectively, as designated by Bechtel. This report includes descriptions of our methodology and procedures, results, and a discussion of our interpretation of the seismic profiles as it pertains to the geologic information provided by Bechtel.

C. Site Description

The site is on gently rolling terrain where surface elevations generally range between about 600 and 675 feet above sea level. Previous investigations by Bechtel National, Inc. and others have described the geologic conditions in some detail. The lithology includes six unconsolidated overburden units that overly the Burlington/Keokuk formation. Generally, the overburden is listed (from the ground surface) as consisting of topsoil, modified loess, clay (Ferrelview formation), clay till, basal till, and cherty clay. Not all of these units are believed to exist everywhere under the site, therefore the overburden lithology varies. The bedrock is described as a cherty limestone that is gradationally weathered and highly variable within the upper 40 feet or so and therefore has a highly irregular surface. Competent Burington/Keokuk formation, fine- to coarse-grained limestone that is locally fractured and solutioned with voids, underlies the gradationally weathered zone.

III METHODOLOGY

A. Data Acquisition

Seismic refraction data was obtained from two profiles referred to as Profiles A and B on the Location Map, Plate 1. As initially planned, the profiles were to be comprised of 200 ft. long geophone spreads using a hammer and plate seismic source. This was based on the assumption that higher velocity material (bedrock) is less than 50 feet deep as generally defined by previous investigations in nearby areas. However, the preliminary in-field analysis of the seismic data following the first day of data acquisition, indicated that the higher velocity material was deeper than anticipated. This necessitated modifying the approach and using the field procedures described below.

Seismic refraction Profiles A and B are comprised of a total of 8 and 7 geophone spreads each, repectively. Each spread is a colinear array of 12 geophones distributed at 25 foot intervals. Shot points were located at both ends of each spread 10 feet from the first geophone, making the total length of each spread 295 feet.

Seismic energy was provided by small explosive charges buried in the ground at depths of 2 to 3 feet. The explosives consisted of approximately one-quarter pound charges of 55% seismic gel detonated by instantaneous electric blasting caps attached to a seismograph high voltage blaster. Mark Products, Inc. digital grade geophones and a Geometrics ES-1210F 12-channel signal enhancement engineering seismograph were used to record the seismic data.

B. Data Analysis

The amount of time it takes for a seismic compressional wave to travel from a shot point to each geophone in a spread is given on the seismic records for each shot. We plotted these data versus the shot point-to-geophone distances in the form of time versus distance (T-D) graphs. By fitting straight line segments to the arrival times, we identified the various seismic layers and determined their apparent velocities. These parameters and the arrival times served as input to computer programs which use both the time-intercept and time-delay methods to invert the seismic refraction data. The output consists of tables listing the true velocity of each seismic layer and the depth to the top of each layer beneath every shot point and geophone. From these tables, seismic velocity cross-sections were then constructed.

In addition, a velocity analysis of the deepest layer in each spread was performed. The analysis consists of determining the interval velocity of the layer between geophones. This defines lateral variations in velocity and aides in correlation between spreads.

C. Limitations

Several assumptions and limiting factors should be considered when interpreting and/or applying seismic refraction information. These assumptions and limitations are inherent to the technique and are common to most interpretation routines. They are as follows:

1) The seismic velocity increases with depth, that is, the velocity of each layer is greater than that of the layers overlying it. If this is not the case, then the low velocity layer will not be detected and the computed depth to all the layers underlying it will be erroneous.

2) Lithologic layers will not be individually resolved unless their velocity contrasts with that of adjacent layers. Conversely, variations in the elastic properties of a given lithologic unit may result in two or more seismic layers corresponding to a single lithologic layer.

3) Unless otherwise designated, seismic layers are assumed to have a constant velocity along the entire length of the respective geophone spread.

4) Steeply dipping velocity layers may cause inaccurate depth estimates.

5) The depths to each seismic layer may not be straight down if the interface is not as deep off to the side of the profile as it is directly beneath it. This can be especially true where seismic interfaces are extremely irregular.

6) The velocity of a seismic layer can vary with direction depending upon the orientation of bedding planes, joints, fractures, etc. relative to the seismic profile. This can result in a slight discrepancy in the computed velocity and depth of seismic layers between crossing profiles.

IV RESULTS

The results of our seismic refraction survey are presented in the form of seismic velocity cross-sections as shown on Plate 2. Each profile (cross-section) shows the position of the ground surface and the underlying seismic interfaces, the velocities of the seismic layers, and the locations of the shot points. Also shown are the results of the velocity analysis of the deepest layer. This is indicated along the lower portion of the profile as lateral extent and differences in velocity below the deepest velocity interface.

The seismic data resolves the subsurface into 4 layers for both Profiles A and B. The velocity, thickness or depth, and geologic interpretation of each layer are summarized below:

Layer 1 - 950 to 1200 feet per second (fps); up to 15 feet thick; represents topsoil and possibly other loose overburden such as the modified loess unit.

Layer 2 - Velocity ranges between 1800 and 5000 fps with an average of about 3000 fps; anomalously high and low velocities are located along Profile B; thickness of this layer ranges between about 10 and 43 feet; believed to represent predominately overburden material but probably includes weathered bedrock along the deeper portions of this unit.

Layer 3 - Velocity is 4000 to 7650 fps and averages about 6000 fps; depth to the top of this layer ranges between about 15 and 45 feet; probably represents predominately weathered bedrock, however the upper portion may also include more compacted and/or saturated overburden material.

Layer 4 - 8000 to 25,500 fps but averages about 12,000 fps along Profile A and about 17,000 along Profile B; depth to the top of this unit is 43 to 110 feet, averages about 55 to 60 feet along Profile A and about 70 to 75 feet along Profile B; represents harder more competent and less weathered bedrock.

Reference to the profiles (Plate 2) should be made for specific elevations of the various velocity layers and lateral variations along a particular profile. Several areas along Profiles A and B should be noted as possible anomalous zones due either to noticeable differences in velocities or change in depths of the various seismic interfaces.

Along Profile A there is a significant increase in the thickness of Layer 2 and decrease in the thickness of Layer 3 below Shot Point 7. Below Shot Point 8 and approximately 50 to 75 feet south of Borings G-2 and G-2A, the depth to Layer 4 increases and the velocity decreases to approximately 8000 fps. Local anomalous areas may be beneath Shot Points 5 and 6 where the depth to Layer 3 is minimal.

Along Profile B, the most noticeable anomalous areas are the depressions of the Layer 4 interface east of Shot Point 4 and beneath Shot Point 8. A more subtle anomaly is the increase in velocity of Layer 2 to 5000 fps beneath Shot Point 3.

V DISCUSSION

Our interpretation of the seismic profiles indicates that the subsurface conditions are irregular and in many places probably erratic. This interpretation is based on high quality data and therefore has been little influenced by random error and "data scatter" during the data reduction and interpretation process. During this process, however, many of the assumptions and limiting factors inherent in the seismic refraction technique, as noted in Section IIIC, Limitations, have been strongly considered in order to derive a geologically reasonable interpretation. The most important of these limitations that may be applicable to the site conditions are: 1) it is assumed that the seismic velocity increases with depth and that each seismic layer has a higher velocity than the material above it; 2) seismic layers are assumed to have a constant velocity along the entire length of a particular geophone spread; and 3) lithologic layers may not be individually resolved unless they have a velocity contrast with adjacent layers.

A comparison of borehole data (2 boreholes along each profile) with the seismic profiles indicates that the contact between the overburden material and the upper bedrock surface is probably not clear and distinct along the entire length of each profile. Since the velocity in the weathered and solutioned bedrock is probably similiar to that in the lower portion of the overburden, the seismic interface representing that boundary is probably only an approximation. This means that the depth to weathered bedrock (as defined geologically) may vary somewhat from what is indicated by the seismic profiles. It is conceiveable that locally this variance could be as much as 10 or 20 feet.

The depth to harder, more competent and higher velocity rock, is also irregular and probably affected by lateral differences in the weathering and solutioning of the shallower rock. Areas along the profiles where the high velocity rock is relatively deep indicate zones where the weathering and solutioning have affected the bedrock to a greater depth. This seismic interface between the lower and higher velocity rock is also believed to represent a gradational zone rather than a distinct change. Therefore, the depth to this boundary at a specific locality may vary from what is depicted by the seismic profiles. However, the variance is probably less than the 10 or 20 feet mentioned above for the overburden/weathered bedrock interface. Further evidence of the variability in the competent rock is provided by the results of the velocity analysis which indicates variations ranging up to approximately 8000 fps.

The difference in the average velocity of the more competent rock between Profiles A and B may be related to the profile orientation, since the velocity of a seismic layer can vary with direction depending upon the orientation of bedding planes, joints, fractures, etc. This is consistent with the reported orientation of fracture sets which trend N30 to 72E and N30 to 65W. Typically, seismic velocities are slightly higher parallel to the structure and lower perpendicular to it.

VI ILLUSTRATIONS

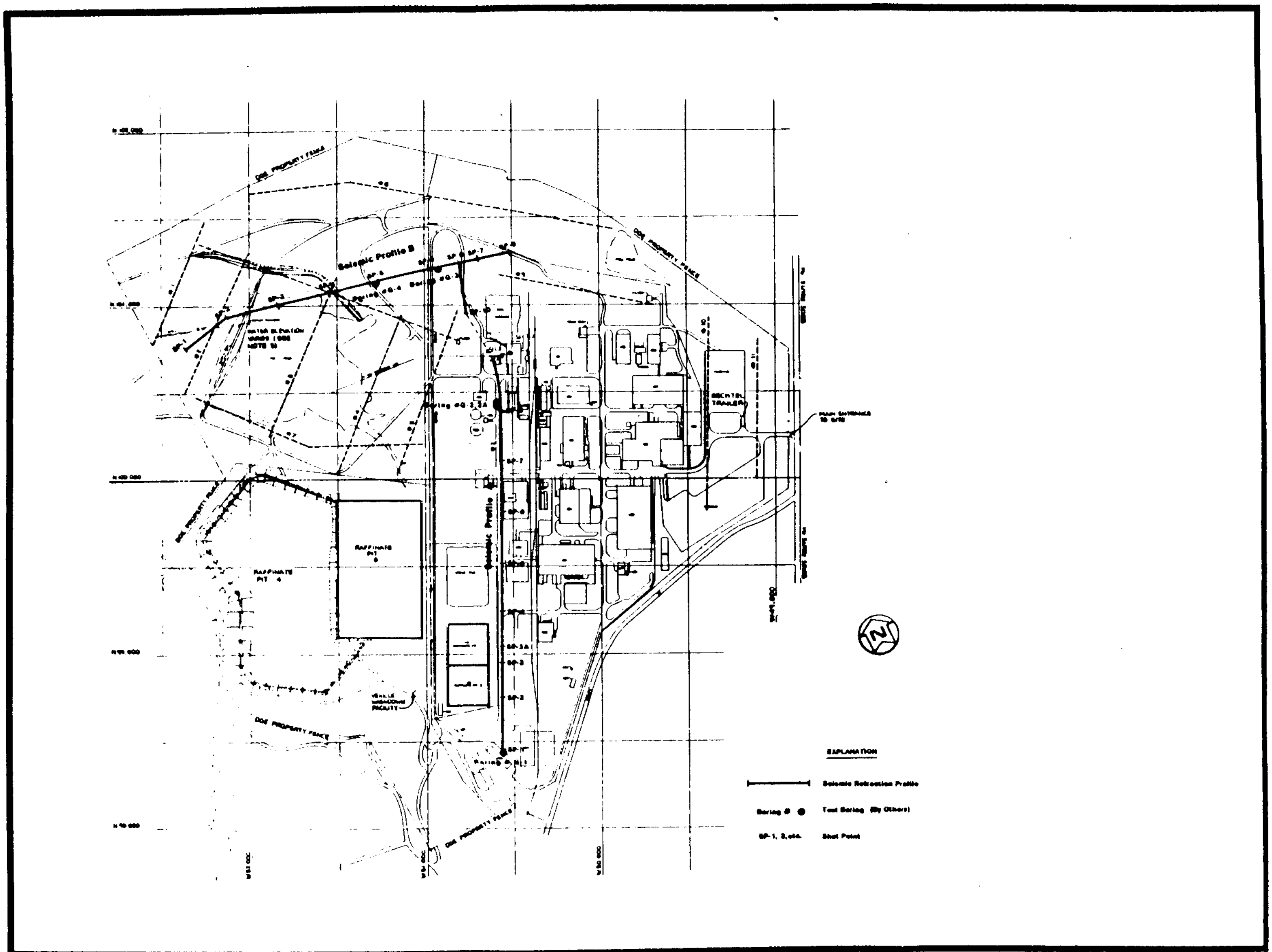


FIGURE C-1 LOCATION MAP (PLATE 1)

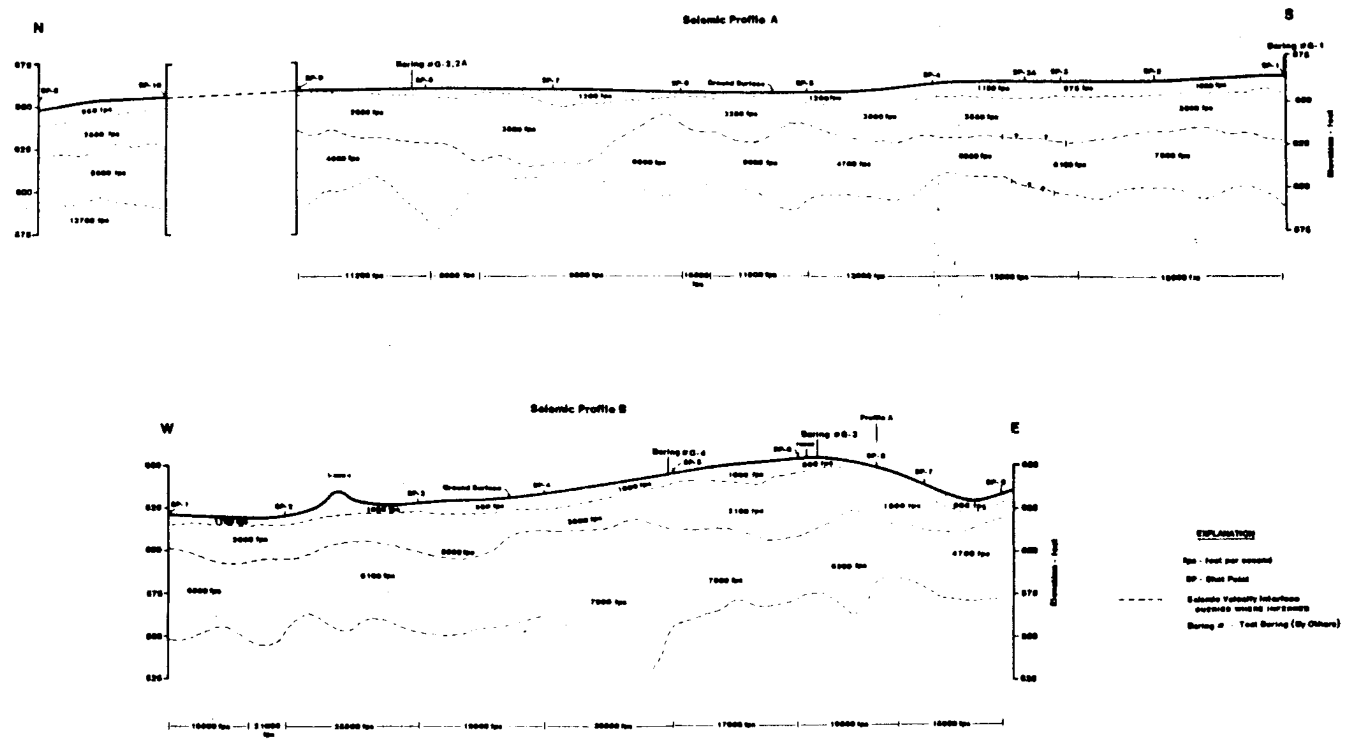


FIGURE C-2 SEISMIC PROFILES A AND B (PLATE 2)

Appendix A

SEISMIC REFRACTION METHOD

The seismic refraction method consists of measuring the travel times of compressional waves through the subsurface. Seismic wave energy transmitted into the ground is refracted along velocity interfaces and back to the surface. By measuring the travel time of seismic waves from a source (shotpoint) to detectors at known distances along the ground surface, the seismic velocities and thicknesses of the respective seismic layers can be determined.

The effective depth of investigation can vary depending upon subsurface conditions. Typically, the depth of investigation for a given seismic profile is approximately one-third to one-fourth the maximum shot point to geophone distance, depending on the velocity contrast between the various seismic layers. Large contrasts in velocity can be detected at a greater depth than small velocity contrasts. Therefore, the depth of penetration can vary from one seismic profile to another.

Several energy sources can be used to generate seismic compressional waves. The two most common are small explosive charges detonated with electric blasting caps or a sledge hammer striking a steel plate. The latter is typically used for shallow investigations to depths of about 50 feet, whereas, explosives can be used for both shallow and deep surveys.

Shot points are typically located at both ends of a geophone line (spread) in order to detect and account for dipping seismic layers. Occasionally, interior shot points are located within a spread to more accurately define significant lateral velocity contrasts, to account for large topographic changes, or to increase the definition of shallow layers. Offset shot points located some distance away from the geophone spread can be used to attain a greater depth of penetration and to increase the definition of deeper layers. However, these do not provide data from the shallower layers along the particular spread.

Seismic refraction data is normally reduced by computer. Prior to computer data reduction, the seismic travel times to each of the geophones from the shot points are plotted on time versus distance graphs to determine the number of seismic layers and apparent velocities. This information along with ground surface elevations is then entered into two computer programs which compute the true velocities, the depths to, and/or thicknesses of the seismic layers. One program determines the depths and thicknesses under the shot points by a time-intercept method (Ewing and Press, Encyclopedia of Geophysics, 1961). The second program, referred to as the plus-minus method computes the layers under geophone locations for a particular spread (Hagedoorn, 1959, Geophysical Prospecting , v. 7, p. 158-182.).

The seismic velocity of earth materials is dependent on physical properties such as density, compaction, hardness, induration, and saturation. Other factors such as bedding fracturing, weathering and alteration, also affect velocity. Generally saturated and/or poorly to semi-consolidated sediments will have a higher seismic velocity than unsaturated and/or unconsolidated material. In regards to bedrock, bedded and/or fractured or weathered rock will have a lower velocity than massive unfractured rock. Alteration of rock such as solutioning in limestone will tend to reduce the seismic velocity.

Because of the assumptions and limitations inherent to the seismic refraction method, seismic models should not be taken as an exact depiction of subsurface lithologic conditions. Since seismic velocities are typically measured over a large area and are dependant on the in-situ physical properties of subsurface materials, they may provide a better indication of certain characteristics than borehole data. However, it is best to consider seismic refraction models as an approximation of the subsurface geology. This is especially true in the absence of correlating subsurface data, or "ground truth." Seismic refraction data can best be utilized when it is correlated with borings or other subsurface information. This aids in eliminating some of the variables and reducing the assumptions that must be employed in its interpretation.

DISTRIBUTION

2 copies: Bechtel National, Inc.
Jackson Plaza Tower
800 Oak Ridge Turnpike
Oak Ridge, Tennessee 37831-0350

Attention: Mr. Mark Jones

APPENDIX D
SOIL TESTING DATA

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-309-21A **Client I.D.:** G-5 SS-3

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size 1mm
Specific gravity if High --- or Low ---
Hardness Soft, cohesive when wet

Sieve Analysis

Grain size percentages and descriptions — **Percentages**

Gravel-(Retained on No. 4 Sieve; 4.75mm) — 0
Description:

Coarse sand-(Retained on No. 10 Sieve; 2.0mm) — 0
Description:

Medium sand-(Retained on No. 40 Sieve; 0.425mm) — 14
Description: Mostly quartz, some limestone fragments subrounded and limonite "balls".

Fine Sand-(Retained on No. 200 Sieve; 0.075mm) — 17
Description: Same as above subangular

Total Sand: — 31

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	27
Clay-(.005mm to .001mm)	8
Colloids-(Less than .001mm)	34
Total Silt/Clay/Colloids:	69

SPECIFIC GRAVITY: ASTM Method D854 ---

UNIT WEIGHT: Volumetric Method --- pcf-wet
--- pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit ---
Plastic Limit ---
Plastic Index ---

PERCENT MOISTURE: ASTM Method D 2216-80 ---

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 ---

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-310-01A **Client I.D.:** G-5-ST-1

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size 5mm
Specific gravity if High --- or Low ---
Hardness Soft and cohesive when wet.

Sieve Analysis

Grain size percentages and descriptions

Grain size percentages and descriptions	Percentages
Gravel-(Retained on No. 4 Sieve; 4.75mm) Description: Subrounded limestone grain.	< 1
Coarse sand-(Retained on No. 10 Sieve; 2.0mm) Description: Subrounded limonitic grains.	< 1
Medium sand-(Retained on No. 40 Sieve; 0.425mm) Description: Subangular to subrounded quartz, and subrounded limestone.	3
Fine Sand-(Retained on No. 200 Sieve; 0.075mm) Description: Same as above	17%
Total Sand:	20

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	31
Clay-(.005mm to .001mm)	3
Colloids-(Less than .001mm)	41
Total Silt/Clay/Colloids:	3[illegible]

SPECIFIC GRAVITY: ASTM Method D854 2.43

UNIT WEIGHT: Volumetric Method 129.5 pcf-wet
105.4 pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit 53
Plastic Limit 17
Plastic Index 36

PERCENT MOISTURE: ASTM Method D 2216-80 22.9%

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 34%

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-309-22A **Client I.D.:** G-6-1

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size ---
Specific gravity if High --- or Low ---
Hardness ______

<u>Sieve Analysis</u>

Grain size percentages and descriptions — **Percentages**

Grain size	Percentages
Gravel-(Retained on No. 4 Sieve; 4.75mm) Description:	---
Coarse sand-(Retained on No. 10 Sieve; 2.0mm) Description:	---
Medium sand-(Retained on No. 40 Sieve; 0.425mm) Description:	---
Fine Sand-(Retained on No. 200 Sieve; 0.075mm) Description:	---
Total Sand:	---

<u>Hydrometer Analysis</u>

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	---
Clay-(.005mm to .001mm)	---
Colloids-(Less than .001mm)	---
Total Silt/Clay/Colloids:	---

SPECIFIC GRAVITY: ASTM Method D854 2.67 g/cm^3

UNIT WEIGHT: Volumetric Method --- pcf-wet
--- pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit ---
Plastic Limit ---
Plastic Index ---

PERCENT MOISTURE: ASTM Method D 2216-80 ---

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 ---

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-310-02A **Client I.D.:** G-6-3

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size 7.0mm
Specific gravity if High --- or Low ---
Hardness Soft and cohesive when wet.

Sieve Analysis

Grain size percentages and descriptions | **Percentages**

Gravel-(Retained on No. 4 Sieve; 4.75mm) — 1
Description: Subrounded, granite and gneissie grains.

Coarse sand-(Retained on No. 10 Sieve; 2.0mm) — 1
Description: Subrounded limonitic and limestone grains.

Medium sand-(Retained on No. 40 Sieve; 0.425mm) — 5
Description: Subangular quartz, subrounded limestone with crinoid fragments (silicified)

Fine Sand-(Retained on No. 200 Sieve; 0.075mm) — 16
Description: Subangular quartz, subrounded limestone and limonitic.

Total Sand & Gravel: — 23

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm) — 32
Clay-(.005mm to .001mm) — 8
Colloids-(Less than .001mm) — 37
Total Silt/Clay/Colloids: — 77

SPECIFIC GRAVITY: ASTM Method D854 2.65 g/cm^3

UNIT WEIGHT: Volumetric Method 136.6 pcf-wet
110.6 pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit 46
Plastic Limit 17
Plastic Index 29

PERCENT MOISTURE: ASTM Method D 2216-80 18.0%

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 36%

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-309-23A **Client I.D.:** G-8-1

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size 5mm
Specific gravity if High ______ or Low 2.36
Hardness Soft and cohesive when wet

Sieve Analysis

Grain size percentages and descriptions — **Percentages**

Gravel-(Retained on No. 4 Sieve; 4.75mm) — 5
Description: Limestone fragments angular

Coarse sand-(Retained on No. 10 Sieve; 2.0mm) — 1
Description: Quartz, rounded, limestone fragments angular

Medium sand-(Retained on No. 40 Sieve; 0.425mm) — 2
Description: Some quartz, with limestone fragments.

Fine Sand-(Retained on No. 200 Sieve; 0.075mm) — 6
Description: Quartz-considerable organic trash.

Total Sand: — 14

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	47
Clay-(.005mm to .001mm)	12
Colloids-(Less than .001mm)	27
Total Silt/Clay/Colloids:	86.

SPECIFIC GRAVITY: ASTM Method D854 ---

UNIT WEIGHT: Volumetric Method --- pcf-wet
--- pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit ---
Plastic Limit ---
Plastic Index ---

PERCENT MOISTURE: ASTM Method D 2216-80 ---

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 ---

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-310-03A **Client I.D.:** G-8-3

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size 1.5mm
Specific gravity if High --- or Low ---
Hardness Soft and cohesive when wet.

Sieve Analysis

Grain size percentages and descriptions — **Percentages**

Gravel-(Retained on No. 4 Sieve; 4.75mm) ---
Description:

Coarse sand-(Retained on No. 10 Sieve; 2.0mm) ---
Description:

Medium sand-(Retained on No. 40 Sieve; 0.425mm) 1
Description: Subangular quartz, subrounded limestone and limonitic grains

Fine Sand-(Retained on No. 200 Sieve; 0.075mm) 3
Description: Same as above

Total Sand: 4

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	47
Clay-(.005mm to .001mm)	8
Colloids-(Less than .001mm)	41
Total Silt/Clay/Colloids:	96

SPECIFIC GRAVITY: ASTM Method D854 2.53 g/cm^3

UNIT WEIGHT: Volumetric Method 127.3 pcf-wet
115.1 pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit 49
Plastic Limit 16
Plastic Index 33

PERCENT MOISTURE: ASTM Method D 2216-80 24.5%

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 41%

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-310-04A **Client I.D.:** G-8 6

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size 4.5mm
Specific gravity if High --- or Low ---
Hardness Soft and cohesive when wet.

Sieve Analysis

Grain size percentages and descriptions — Percentages

Gravel-(Retained on No. 4 Sieve; 4.75mm) ---
Description:

Coarse sand-(Retained on No. 10 Sieve; 2.0mm) 1
Description: Subangular limestone and quartz, subrounded limonitic grains.

Medium sand-(Retained on No. 40 Sieve; 0.425mm) 4
Description: Subangular quartz, and subrounded limonite and limestone grains.

Fine Sand-(Retained on No. 200 Sieve; 0.075mm) 17
Description: Same as above

Total Sand: 22

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm) 32
Clay-(.005mm to .001mm) 15
Colloids-(Less than .001mm) 36
Total Silt/Clay/Colloids: 73

SPECIFIC GRAVITY: ASTM Method D854 2.61 g/cm^3

UNIT WEIGHT: Volumetric Method 121.1 pcf-wet
103.9 pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit 47
Plastic Limit 16
Plastic Index 31

PERCENT MOISTURE: ASTM Method D 2216-80 16.9

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 33%

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-310-10A **Client I.D.:** G-9-2

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size 3.5mm
Specific gravity if High --- or Low ---
Hardness Soft and cohesive when wet.

Sieve Analysis

Grain size percentages and descriptions	**Percentages**
Gravel-(Retained on No. 4 Sieve; 4.75mm) Description:	---
Coarse sand-(Retained on No. 10 Sieve; 2.0mm) Description: One angular chert fragment.	<1
Medium sand-(Retained on No. 40 Sieve; 0.425mm) Description: Mostly subangular chert and quartz, subrounded limonitic grains.	1
Fine Sand-(Retained on No. 200 Sieve; 0.075mm) Description: Same as above	2
Total Sand:	3

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	56
Clay-(.005mm to .001mm)	8
Colloids-(Less than .001mm)	33
Total Silt/Clay/Colloids:	97

SPECIFIC GRAVITY: ASTM Method D854 2.63 g/cm^3

UNIT WEIGHT: Volumetric Method 124.0 pcf-wet
103.5 pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit 40
Plastic Limit 17
Plastic Index 23

PERCENT MOISTURE: ASTM Method D 2216-80 24.6%

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 35%

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-310-11A **Client I.D.:** G-9-5

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size 3.5mm
Specific gravity if High --- or Low ---
Hardness Soft & cohesive when wet

Sieve Analysis

Grain size percentages and descriptions — **Percentages**

Gravel-(Retained on No. 4 Sieve; 4.75mm) — 0
Description:

Coarse sand-(Retained on No. 10 Sieve; 2.0mm) — <1
Description: Basalt chips, subangular subrounded quartz and limonitic grains.

Medium sand-(Retained on No. 40 Sieve; 0.425mm) — 4
Description: Quartz limonitic grains, limestone, subrounded.

Fine Sand-(Retained on No. 200 Sieve; 0.075mm) — 17
Description: Same as above

Total Sand: — 21

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	30
Clay-(.005mm to .001mm)	10
Colloids-(Less than .001mm)	39
Total Silt/Clay/Colloids:	79

SPECIFIC GRAVITY: ASTM Method D854 2.60 g/cm^3

UNIT WEIGHT: Volumetric Method 127.6 pcf-wet
107.3 pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit 50
Plastic Limit 16
Plastic Index 34

PERCENT MOISTURE: ASTM Method D 2216-80 18.7%

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 45%

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-309-17A **Client I.D.:** G-10- SS-2

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size ---
Specific gravity if High --- or Low ---
Hardness

Sieve Analysis

Grain size percentages and descriptions — **Percentages**

Gravel-(Retained on No. 4 Sieve; 4.75mm) Description:	---
Coarse sand-(Retained on No. 10 Sieve; 2.0mm) Description:	---
Medium sand-(Retained on No. 40 Sieve; 0.425mm) Description:	---
Fine Sand-(Retained on No. 200 Sieve; 0.075mm) Description:	---
Total Sand:	---

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	---
Clay-(.005mm to .001mm)	---
Colloids-(Less than .001mm)	---
Total Silt/Clay/Colloids:	---

SPECIFIC GRAVITY: ASTM Method D854

UNIT WEIGHT: Volumetric Method 126.5 pcf-wet
107.9 pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit ---
Plastic Limit ---
Plastic Index ---

PERCENT MOISTURE: ASTM Method D 2216-80 ---

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 ---

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-309-18A **Client I.D.:** G-10- SS-4

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size ---
Specific gravity if High --- or Low ---
Hardness ______

Sieve Analysis

Grain size percentages and descriptions

	Percentages
Gravel-(Retained on No. 4 Sieve; 4.75mm) Description: ______	---
Coarse sand-(Retained on No. 10 Sieve; 2.0mm) Description: ______	---
Medium sand-(Retained on No. 40 Sieve; 0.425mm) Description: ______	---
Fine Sand-(Retained on No. 200 Sieve; 0.075mm) Description: ______	---
Total Sand:	---

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	---
Clay-(.005mm to .001mm)	---
Colloids-(Less than .001mm)	---
Total Silt/Clay/Colloids:	---

SPECIFIC GRAVITY: ASTM Method D854 2.62 g/cm^3

UNIT WEIGHT: Volumetric Method --- pcf-wet
--- pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit ---
Plastic Limit ---
Plastic Index ---

PERCENT MOISTURE: ASTM Method D 2216-80 ---

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 ---

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-309-24A **Client I.D.:** G-14-1

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size ---
Specific gravity if High --- or Low ---
Hardness ____

Sieve Analysis

Grain size percentages and descriptions — **Percentages**

Grain size	Percentages
Gravel-(Retained on No. 4 Sieve; 4.75mm) Description:	---
Coarse sand-(Retained on No. 10 Sieve; 2.0mm) Description:	---
Medium sand-(Retained on No. 40 Sieve; 0.425mm) Description:	---
Fine Sand-(Retained on No. 200 Sieve; 0.075mm) Description:	---
Total Sand:	---

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	---
Clay-(.005mm to .001mm)	---
Colloids-(Less than .001mm)	---
Total Silt/Clay/Colloids:	---

SPECIFIC GRAVITY: ASTM Method D854 2.45 g/cm^3

UNIT WEIGHT: Volumetric Method --- pcf-wet
--- pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit ---
Plastic Limit ---
Plastic Index ---

PERCENT MOISTURE: ASTM Method D 2216-80 ---

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 ---

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-309-25A **Client I.D.:** G-15-7

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size 1.8mm
Specific gravity if High --- or Low 2.44
Hardness Soft, cohesive when wet

Sieve Analysis

Grain size percentages and descriptions

Grain size	Percentages
Gravel-(Retained on No. 4 Sieve; 4.75mm) Description:	0
Coarse sand-(Retained on No. 10 Sieve; 2.0mm) Description:	0
Medium sand-(Retained on No. 40 Sieve; 0.425mm) Description: Quartz, subrounded	4
Fine Sand-(Retained on No. 200 Sieve; 0.075mm) Description: Same as medium sand	4
Total Sand:	8

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	56
Clay-(.005mm to .001mm)	2
Colloids-(Less than .001mm)	34.
Total Silt/Clay/Colloids:	92.

SPECIFIC GRAVITY: ASTM Method D854 ---

UNIT WEIGHT: Volumetric Method 126.5 pcf-wet
104.8 pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit ---
Plastic Limit ---
Plastic Index ---

PERCENT MOISTURE: ASTM Method D 2216-80 ---

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 ---

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-309-26A **Client I.D.:** G-16-1

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size ---
Specific gravity if High --- or Low ---
Hardness ________

Sieve Analysis

Grain size percentages and descriptions — **Percentages**

Grain size	Percentages
Gravel-(Retained on No. 4 Sieve; 4.75mm) Description:	---
Coarse sand-(Retained on No. 10 Sieve; 2.0mm) Description:	---
Medium sand-(Retained on No. 40 Sieve; 0.425mm) Description:	---
Fine Sand-(Retained on No. 200 Sieve; 0.075mm) Description:	---
Total Sand:	---

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	---
Clay-(.005mm to .001mm)	---
Colloids-(Less than .001mm)	---
Total Silt/Clay/Colloids:	---

SPECIFIC GRAVITY: ASTM Method D854 2.62 g/cm^3

UNIT WEIGHT: Volumetric Method --- pcf-wet
--- pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit ---
Plastic Limit ---
Plastic Index ---

PERCENT MOISTURE: ASTM Method D 2216-80 ---

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 ---

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-309-27A **Client I.D.:** G-18-1

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size 0.5mm
Specific gravity if High --- or Low ---
Hardness Soft, cohesive when wet.

Sieve Analysis

Grain size percentages and descriptions — **Percentages**

Gravel-(Retained on No. 4 Sieve; 4.75mm) 0
Description:

Coarse sand-(Retained on No. 10 Sieve; 2.0mm) 0
Description:

Medium sand-(Retained on No. 40 Sieve; 0.425mm) 1
Description: Quartz, limonitic rock modular-rounded-subrounded

Fine Sand-(Retained on No. 200 Sieve; 0.075mm) 5
Description: Same as above

Total Sand: 6

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm) 65
Clay-(.005mm to .001mm) 8
Colloids-(Less than .001mm) 21
Total Silt/Clay/Colloids: 94

SPECIFIC GRAVITY: ASTM Method D854 ---

UNIT WEIGHT: Volumetric Method --- pcf-wet
--- pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit ---
Plastic Limit ---
Plastic Index ---

PERCENT MOISTURE: ASTM Method D 2216-80 ---

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 ---

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-310-12A **Client I.D.:** G-19-2

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size 5.0mm
Specific gravity if High --- or Low ---
Hardness Soft and cohesive when wet.

Sieve Analysis

Grain size percentages and descriptions — **Percentages**

Gravel-(Retained on No. 4 Sieve; 4.75mm) — <1
Description: Angular chert grain

Coarse sand-(Retained on No. 10 Sieve; 2.0mm) — 1
Description: Chert and limestone grains subrounded.

Medium sand-(Retained on No. 40 Sieve; 0.425mm) — 5
Description: Quartz and chert, subrounded

Fine Sand-(Retained on No. 200 Sieve; 0.075mm) — 21
Description: Quartz-subangular, subrounded, trace of limestone and limonite

Total Sand: — 27

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	29
Clay-(.005mm to .001mm)	6
Colloids-(Less than .001mm)	38
Total Silt/Clay/Colloids:	73

SPECIFIC GRAVITY: ASTM Method D854 2.68 g/cm^3

UNIT WEIGHT: Volumetric Method 125.9 pcf-wet
107.9 pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit	41
Plastic Limit	14
Plastic Index	27

PERCENT MOISTURE: ASTM Method D 2216-80 16.9%

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 37%

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-310-13A **Client I.D.:** G-20-2

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size 3.0mm
Specific gravity if High --- or Low ---
Hardness Soft and cohesive when wet.

Sieve Analysis

Grain size percentages and descriptions	Percentages
Gravel-(Retained on No. 4 Sieve; 4.75mm) Description:	0
Coarse sand-(Retained on No. 10 Sieve; 2.0mm) Description: Chert and quartz-subangular some limestone grains.	<1
Medium sand-(Retained on No. 40 Sieve; 0.425mm) Description: Mostly quartz-subangular subrounded, some chert and limonitic grains.	3
Fine Sand-(Retained on No. 200 Sieve; 0.075mm) Description: Quartz-subangular with limonitic grains subrounded.	11
Total Sand:	14

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	36
Clay-(.005mm to .001mm)	5
Colloids-(Less than .001mm)	45
Total Silt/Clay/Colloids:	86

SPECIFIC GRAVITY: ASTM Method D854 2.67 g/cm^3

UNIT WEIGHT: Volumetric Method 121.4 pcf-wet
96.7 pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit	62
Plastic Limit	19
Plastic Index	43

PERCENT MOISTURE: ASTM Method D 2216-80 23.5%

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 46%

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-309-28A **Client I.D.:** G-21 SS-1

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size ---
Specific gravity if High --- or Low ---
Hardness ______

Sieve Analysis

Grain size percentages and descriptions | **Percentages**

Gravel-(Retained on No. 4 Sieve; 4.75mm) ---
Description: ______

Coarse sand-(Retained on No. 10 Sieve; 2.0mm) ---
Description: ______

Medium sand-(Retained on No. 40 Sieve; 0.425mm) ---
Description: ______

Fine Sand-(Retained on No. 200 Sieve; 0.075mm) ---
Description: ______

Total Sand: ---

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	---
Clay-(.005mm to .001mm)	---
Colloids-(Less than .001mm)	---
Total Silt/Clay/Colloids:	---

SPECIFIC GRAVITY: ASTM Method D854 2.58 g/cm^3

UNIT WEIGHT: Volumetric Method --- pcf-wet
--- pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit ---
Plastic Limit ---
Plastic Index ---

PERCENT MOISTURE: ASTM Method D 2216-80 ---

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 ---

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-309-29A **Client I.D.:** G-21 SS-2

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size ---
Specific gravity if High --- or Low ---
Hardness ______

Sieve Analysis

Grain size percentages and descriptions — **Percentages**

Gravel-(Retained on No. 4 Sieve; 4.75mm) ---
Description: ______

Coarse sand-(Retained on No. 10 Sieve; 2.0mm) ---
Description: ______

Medium sand-(Retained on No. 40 Sieve; 0.425mm) ---
Description: ______

Fine Sand-(Retained on No. 200 Sieve; 0.075mm) ---
Description: ______

Total Sand: ---

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	---
Clay-(.005mm to .001mm)	---
Colloids-(Less than .001mm)	---
Total Silt/Clay/Colloids:	---

SPECIFIC GRAVITY: ASTM Method D854 ______

UNIT WEIGHT: Volumetric Method --- pcf-wet
--- pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit	63
Plastic Limit	20
Plastic Index	43

PERCENT MOISTURE: ASTM Method D 2216-80 ---

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 ---

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-309-30A **Client I.D.:** G-21/SS-5

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size 0.5mm
Specific gravity if High --- or Low ---
Hardness Soft and cohesive when wet.

Sieve Analysis

Grain size percentages and descriptions **Percentages**

Gravel-(Retained on No. 4 Sieve; 4.75mm) 0
Description:

Coarse sand-(Retained on No. 10 Sieve; 2.0mm) 0
Description:

Medium sand-(Retained on No. 40 Sieve; 0.425mm) 1%
Description: Subrounded limonitic and limestone grains, subangular quartz.

Fine Sand-(Retained on No. 200 Sieve; 0.075mm) 5%
Description: Same as above

Total Sand: 6%

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	63
Clay-(.005mm to .001mm)	11
Colloids-(Less than .001mm)	20
Total Silt/Clay/Colloids:	94

SPECIFIC GRAVITY: ASTM Method D854

UNIT WEIGHT: Volumetric Method 114.1 pcf-wet
99.4 pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit 35
Plastic Limit 16
Plastic Index 19

PERCENT MOISTURE: ASTM Method D 2216-80 ---

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 ---

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-310-09A **Client I.D.:** G-21 ST-1

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size 2.8mm
Specific gravity if High --- or Low ---
Hardness Soft and cohesive when wet.

Sieve Analysis

Grain size percentages and descriptions | **Percentages**

Gravel-(Retained on No. 4 Sieve; 4.75mm) ---
Description:

Coarse sand-(Retained on No. 10 Sieve; 2.0mm) 1
Description: Subangular chert and quartz widely scattered limonite

Medium sand-(Retained on No. 40 Sieve; 0.425mm) 5
Description: Mostly subangular quartz

Fine Sand-(Retained on No. 200 Sieve; 0.075mm) 21
Description: Subangular quartz grains

Total Sand: 27

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	31
Clay-(.005mm to .001mm)	7
Colloids-(Less than .001mm)	35
Total Silt/Clay/Colloids:	73

SPECIFIC GRAVITY: ASTM Method D854 2.64 g/cm^3

UNIT WEIGHT: Volumetric Method --- pcf-wet
--- pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit 42
Plastic Limit 13
Plastic Index 29

PERCENT MOISTURE: ASTM Method D 2216-80 14.2%

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 ---

10/86

SOILS ANALYSIS

CHEMICAL TEST

Sample Number: 8609310-09A Client I.D.: G-21 ST-1

CATION EXCHANGE CAPACITY; Hoddinott Method

Exchange Acidity, meq/100g o.d. soil = 29.84

Exchange Cation Content, meq/100g o.d. soil (Ca) = 22.40

(Mg) = 7.13

(K) = 0.49

(Na) = 0.98

ECEC = effective cation exchange capacity, meq/100g o.d. soil.

ECEC = 60.8

DISTRIBUTION RATIOS; Method D-4320-84 - See separate report.

SOILS ANALYSIS

CHEMICAL TEST

Sample Number: 8609310-09A Pro Dup Client I.D.: C-21 ST-1

CATION EXCHANGE CAPACITY; Hoddinott Method

Exchange Acidity, meq/100g o.d. soil = 28.61

Exchange Cation Content, meq/100g o.d. soil (Ca) = 22.74

(Mg) = 7.05

(K) = 0.49

(Na) = 1.00

ECEC = effective cation exchange capacity, meq/100g o.d. soil.

ECEC = 59.9

DISTRIBUTION RATIOS; Method D-4320-84 - See separate report.

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-309-01A **Client I.D.:** GMW-1 SS-1

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size ---
Specific gravity if High --- or Low ---
Hardness ---

Sieve Analysis

Grain size percentages and descriptions

	Percentages
Gravel-(Retained on No. 4 Sieve; 4.75mm) Description:	---
Coarse sand-(Retained on No. 10 Sieve; 2.0mm) Description:	---
Medium sand-(Retained on No. 40 Sieve; 0.425mm) Description:	---
Fine Sand-(Retained on No. 200 Sieve; 0.075mm) Description:	---
Total Sand:	---

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	---
Clay-(.005mm to .001mm)	---
Colloids-(Less than .001mm)	---
Total Silt/Clay/Colloids:	---

SPECIFIC GRAVITY: ASTM Method D854 ---

UNIT WEIGHT: Volumetric Method --- pcf-wet
--- pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit 30
Plastic Limit 17
Plastic Index 13

PERCENT MOISTURE: ASTM Method D 2216-80 ---

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-309-42A **Client I.D.:** GMW-1-ST-1

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size 24mm
Specific gravity if High --- or Low ---
Hardness When dry, very friable

Sieve Analysis

Grain size percentages and descriptions — **Percentages**

Gravel-(Retained on No. 4 Sieve; 4.75mm) — 39
Description: 3/4" - 21%, No. 4 - 18% angular chert nodules.

Coarse sand-(Retained on No. 10 Sieve; 2.0mm) — 11
Description: Angular chert grains

Medium sand-(Retained on No. 40 Sieve; 0.425mm) — 10
Description: Angular chert grains

Fine Sand-(Retained on No. 200 Sieve; 0.075mm) — 5
Description: Angular chert, with trace amounts of subrounded limonitic grains.

Total Sand & Gravel. — 65

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	10
Clay-(.005mm to .001mm)	2
Colloids-(Less than .001mm)	23
Total Silt/Clay/Colloids:	35

SPECIFIC GRAVITY: ASTM Method D854 2.45 g/cm^3

UNIT WEIGHT: Volumetric Method 107.9 pcf-wet
86.5 pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit 66
Plastic Limit 23
Plastic Index 43

PERCENT MOISTURE: ASTM Method D 2216-80 23.9%

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 40%

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-310-05A **Client I.D.:** GMW-2 ST-1

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size 1.5"
Specific gravity if High --- or Low ---
Hardness Soft & cohesive when wet

Sieve Analysis

Grain size percentages and descriptions

Grain size	**Percentages**
Gravel-(Retained on No. 4 Sieve; 4.75mm) Description: 1" 7% 1 3/4-5%/ No. 4-13% chert nodules and fragments.	25%
Coarse sand-(Retained on No. 10 Sieve; 2.0mm) Description: Chert grains. Agular and irregular shape.	32%
Medium sand-(Retained on No. 40 Sieve; 0.425mm) Description: Mostly limonitic grains-subrounded and slaglike blebs with minor quartz.	6%
Fine Sand-(Retained on No. 200 Sieve; 0.075mm) Description: Mostly limonitic grains with minor amounts of limestone and quartz.	3%
Total Sand & Gravel:	66%

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	16
Clay-(.005mm to .001mm)	3
Colloids-(Less than .001mm)	15
Total Silt/Clay/Colloids:	3[illegible]

SPECIFIC GRAVITY: ASTM Method D854 ______

UNIT WEIGHT: Volumetric Method ______ pcf-wet
______ pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit 35
Plastic Limit 19
Plastic Index 16

PERCENT MOISTURE: ASTM Method D 2216-80 23.1%

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 ______

10/86

SOILS ANALYSIS
CHEMICAL TEST

Sample Number: 8609310-05A **Client I.D.:** GMW-2 ST-1

CATION EXCHANGE CAPACITY; Hoddinott Method

Exchange Acidity, meq/100g o.d. soil = 9.02

Exchange Cation Content, meq/100g o.d. soil (Ca) = 13.58

(Mg) = 5.49

(K) = 0.46

(Na) = 0.45

ECEC = effective cation exchange capacity, meq/100g o.d. soil.

ECEC = 29.0

DISTRIBUTION RATIOS; Method D-4320-84 - See separate report.

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-309-02A **Client I.D.:** GMW-3 SS-1

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size ~~0.7mm~~
Specific gravity if High --- or Low ---
Hardness ~~Soft & cohesive when wet~~

Sieve Analysis

Grain size percentages and descriptions **Percentages**

Gravel-(Retained on No. 4 Sieve; 4.75mm) ---
Description:

Coarse sand-(Retained on No. 10 Sieve; 2.0mm) ---
Description:

Medium sand-(Retained on No. 40 Sieve; 0.425mm) 2
Description: ~~Claystone and sandstone w/limonite, subrounded grains~~

Fine Sand-(Retained on No. 200 Sieve; 0.075mm) 3
Description: ~~Mostly quartz, subrounded grains~~

Total Sand: 5

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm) 65
Clay-(.005mm to .001mm) 7
Colloids-(Less than .001mm) 23
Total Silt/Clay/Colloids: 95

SPECIFIC GRAVITY: ASTM Method D854 ---

UNIT WEIGHT: Volumetric Method 110.6 pcf-wet
92.3 pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit ---
Plastic Limit ---
Plastic Index ---

PERCENT MOISTURE: ASTM Method D 2216-80 ---

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 ---

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-309-03A **Client I.D.:** GMW-3-SS-2

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size 3.3mm
Specific gravity if High --- or Low ---
Hardness soft & cohesive when wet

Sieve Analysis

Grain size percentages and descriptions	**Percentages**
Gravel-(Retained on No. 4 Sieve; 4.75mm) Description:	
Coarse sand-(Retained on No. 10 Sieve; 2.0mm) Description: Limestone fragments angular to subrounded.	3
Medium sand-(Retained on No. 40 Sieve; 0.425mm) Description: quartz, subrounded	3
Fine Sand-(Retained on No. 200 Sieve; 0.075mm) Description: clear quartz, subrounded	10
Total Sand:	16

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	26
Clay-(.005mm to .001mm)	10
Colloids-(Less than .001mm)	48
Total Silt/Clay/Colloids:	84

SPECIFIC GRAVITY: ASTM Method D854 2.56 g/cm^3

UNIT WEIGHT: Volumetric Method --- pcf-wet
--- pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit ---
Plastic Limit ---
Plastic Index ---

PERCENT MOISTURE: ASTM Method D 2216-80 ---

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 ---

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-309-04A **Client I.D.:** GMW-3 SS-4

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size ---
Specific gravity if High --- or Low ---
Hardness ---

Sieve Analysis

Grain size percentages and descriptions — **Percentages**

	Percentages
Gravel-(Retained on No. 4 Sieve; 4.75mm) Description:	---
Coarse sand-(Retained on No. 10 Sieve; 2.0mm) Description:	---
Medium sand-(Retained on No. 40 Sieve; 0.425mm) Description:	---
Fine Sand-(Retained on No. 200 Sieve; 0.075mm) Description:	---
Total Sand:	---

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	---
Clay-(.005mm to .001mm)	---
Colloids-(Less than .001mm)	---
Total Silt/Clay/Colloids:	---

SPECIFIC GRAVITY: ASTM Method D854 ---

UNIT WEIGHT: Volumetric Method --- pcf-wet
--- pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit 81
Plastic Limit 25
Plastic Index 56

PERCENT MOISTURE: ASTM Method D 2216-80 ---

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 ---

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-309-35A **Client I.D.:** GMW-3 ST-1

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size 1.5mm
Specific gravity if High --- or Low ---
Hardness Soft and cohesive when wet.

Sieve Analysis

Grain size percentages and descriptions	**Percentages**
Gravel-(Retained on No. 4 Sieve; 4.75mm) Description:	---
Coarse sand-(Retained on No. 10 Sieve; 2.0mm) Description:	---
Medium sand-(Retained on No. 40 Sieve; 0.425mm) Description: Mostly quartz, with limonitic and limestone grains, subangular to subrounded.	3
Fine Sand-(Retained on No. 200 Sieve; 0.075mm) Description: Mostly quartz to subrounded grains.	11
Total Sand:	14

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	41
Clay-(.005mm to .001mm)	6
Colloids-(Less than .001mm)	39
Total Silt/Clay/Colloids:	86

SPECIFIC GRAVITY: ASTM Method D854 2.62 g/cm^3

UNIT WEIGHT: Volumetric Method 126.8 pcf-wet
101.7 pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit 55
Plastic Limit 14
Plastic Index 41

PERCENT MOISTURE: ASTM Method D 2216-80 24.7%

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 47%

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-309-05A **Client I.D.:** GMW-4 SS-1

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size ---
Specific gravity if High --- or Low ---
Hardness ---

Sieve Analysis

Grain size percentages and descriptions	Percentages
Gravel-(Retained on No. 4 Sieve; 4.75mm) Description:	---
Coarse sand-(Retained on No. 10 Sieve; 2.0mm) Description:	---
Medium sand-(Retained on No. 40 Sieve; 0.425mm) Description:	---
Fine Sand-(Retained on No. 200 Sieve; 0.075mm) Description:	---
Total Sand:	---

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	---
Clay-(.005mm to .001mm)	---
Colloids-(Less than .001mm)	---
Total Silt/Clay/Colloids:	---

SPECIFIC GRAVITY: ASTM Method D854 ---

UNIT WEIGHT: Volumetric Method 101.7 pcf-wet
85.5 pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit ---
Plastic Limit ---
Plastic Index ---

PERCENT MOISTURE: ASTM Method D 2216-80 ---

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 ---

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-309-06A **Client I.D.:** GMW-4 SS-4

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size 2.5mm
Specific gravity if High 2.72 or Low ---
Hardness Soft and cohesive when wet

Sieve Analysis

Grain size percentages and descriptions	**Percentages**
Gravel-(Retained on No. 4 Sieve; 4.75mm) Description:	---
Coarse sand-(Retained on No. 10 Sieve; 2.0mm) Description: Angular limestone fragments, some quartz grains.	1
Medium sand-(Retained on No. 40 Sieve; 0.425mm) Description: Mostly quartz grains angular angular to subrounded.	4
Fine Sand-(Retained on No. 200 Sieve; 0.075mm) Description: Same as medium sand.	23.
Total Sand:	28.

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	31
Clay-(.005mm to .001mm)	11
Colloids-(Less than .001mm)	30
Total Silt/Clay/Colloids:	72

SPECIFIC GRAVITY: ASTM Method D854 ---

UNIT WEIGHT: Volumetric Method --- pcf-wet
--- pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit ---
Plastic Limit ---
Plastic Index ---

PERCENT MOISTURE: ASTM Method D 2216-80 ---

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 ---

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-329-36A **Client I.D.:** GMW-4 ST-1

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size 3.5mm
Specific gravity if High --- or Low ---
Hardness Soft and cohesive when wet.

Sieve Analysis

Grain size percentages and descriptions — **Percentages**

Gravel-(Retained on No. 4 Sieve; 4.75mm) — 0
Description:

Coarse sand-(Retained on No. 10 Sieve; 2.0mm) — 1
Description: Subangular to subrounded quartz with scattered limonitic grains.

Medium sand-(Retained on No. 40 Sieve; 0.425mm) — 4
Description: Subangular to subrounded quartz grains.

Fine Sand-(Retained on No. 200 Sieve; 0.075mm) — 17
Description: Mostly subangular to subrounded quartz grains.

Total Sand: — 22

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	34
Clay-(.005mm to .001mm)	6
Colloids-(Less than .001mm)	38
Total Silt/Clay/Colloids:	73

SPECIFIC GRAVITY: ASTM Method D854 2.46 g/cm^3

UNIT WEIGHT: Volumetric Method 122.7 pcf-wet
102.9 pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit 48
Plastic Limit 15
Plastic Index 33

PERCENT MOISTURE: ASTM Method D 2216-80 19.7%

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 41%

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-309-07A **Client I.D.:** GMW-5 SS-1

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size 1.9mm
Specific gravity if High --- or Low ---
Hardness Soft, cohesive when wet.

Sieve Analysis

Grain size percentages and descriptions

Grain size percentages and descriptions	Percentages
Gravel-(Retained on No. 4 Sieve; 4.75mm) Description:	---
Coarse sand-(Retained on No. 10 Sieve; 2.0mm) Description:	---
Medium sand-(Retained on No. 40 Sieve; 0.425mm) Description: Quartz grains, subrounded with limonitic "ironstone" fragments.	1
Fine Sand-(Retained on No. 200 Sieve; 0.075mm) Description: Same as above, but with more quartz.	4
Total Sand:	5

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	67
Clay-(.005mm to .001mm)	13%
Colloids-(Less than .001mm)	15%
Total Silt/Clay/Colloids:	95

SPECIFIC GRAVITY: ASTM Method D854 ---

UNIT WEIGHT: Volumetric Method 106.9 pcf-wet
95.2 pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit ---
Plastic Limit ---
Plastic Index ---

PERCENT MOISTURE: ASTM Method D 2216-80 ---

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 ---

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-309-08A **Client I.D.:** GMW-5 SS-5

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size ____
Specific gravity if High --- or Low ---
Hardness ---

Sieve Analysis

Grain size percentages and descriptions | **Percentages**

Gravel-(Retained on No. 4 Sieve; 4.75mm) ---
Description: ____

Coarse sand-(Retained on No. 10 Sieve; 2.0mm) ---
Description: ____

Medium sand-(Retained on No. 40 Sieve; 0.425mm) ---
Description: ____

Fine Sand-(Retained on No. 200 Sieve; 0.075mm) ---
Description: ---

Total Sand: ---

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm) ---
Clay-(.005mm to .001mm) ---
Colloids-(Less than .001mm) ---
Total Silt/Clay/Colloids: ---

SPECIFIC GRAVITY: ASTM Method D854 ---

UNIT WEIGHT: Volumetric Method --- pcf-wet
--- pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit 31
Plastic Limit 17
Plastic Index 14

PERCENT MOISTURE: ASTM Method D 2216-80 ---

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 ---

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-309-37A **Client I.D.:** GMW-5 ST-1

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size 2.7mm
Specific gravity if High --- or Low ---
Hardness Soft and cohesive when wet.

Sieve Analysis

Grain size percentages and descriptions — **Percentages**

Gravel-(Retained on No. 4 Sieve; 4.75mm) ---
Description:

Coarse sand-(Retained on No. 10 Sieve; 2.0mm) 1
Description: Subrounded limestones grains

Medium sand-(Retained on No. 40 Sieve; 0.425mm) 4
Description: Mostly subrounded quartz with scattered limestone and limonitic grains.

Fine Sand-(Retained on No. 200 Sieve; 0.075mm) 21
Description: Same as above

Total Sand: 26

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm) 31
Clay-(.005mm to .001mm) 9
Colloids-(Less than .001mm) 34
Total Silt/Clay/Colloids: 74

SPECIFIC GRAVITY: ASTM Method D854 2.62 g/cm

UNIT WEIGHT: Volumetric Method 132.6 pcf-wet
113.4 pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit 44
Plastic Limit 15
Plastic Index 29

PERCENT MOISTURE: ASTM Method D 2216-80 13.7%

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 34%

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-309-38A **Client I.D.:** GMW-6 ST-1

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size 0.8mm
Specific gravity if High --- or Low ---
Hardness Soft and cohesive when wet.

Sieve Analysis

Grain size percentages and descriptions **Percentages**

Grain size	Percentages
Gravel-(Retained on No. 4 Sieve; 4.75mm) Description:	0
Coarse sand-(Retained on No. 10 Sieve; 2.0mm) Description:	0
Medium sand-(Retained on No. 40 Sieve; 0.425mm) Description: Crinoid fragments, chert fragments, some quartz-all angular to subangular.	5
Fine Sand-(Retained on No. 200 Sieve; 0.075mm) Description: Mostly subangular quartz and chert some limonitic grains present	13
Total Sand:	18

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	28
Clay-(.005mm to .001mm)	17
Colloids-(Less than .001mm)	37
Total Silt/Clay/Colloids:	82

SPECIFIC GRAVITY: ASTM Method D854 2.66 g/cm^3

UNIT WEIGHT: Volumetric Method 121.7 pcf-wet
104.7 pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit 42
Plastic Limit 14
Plastic Index 28

PERCENT MOISTURE: ASTM Method D 2216-80 18.6%

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 34%

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-309-09A **Client I.D.:** GMW-7 SS-1

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size ---
Specific gravity if High --- or Low ---
Hardness ______

Sieve Analysis

Grain size percentages and descriptions

Grain size	Percentages
Gravel-(Retained on No. 4 Sieve; 4.75mm) Description:	---
Coarse sand-(Retained on No. 10 Sieve; 2.0mm) Description:	---
Medium sand-(Retained on No. 40 Sieve; 0.425mm) Description:	---
Fine Sand-(Retained on No. 200 Sieve; 0.075mm) Description:	---
Total Sand:	---

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	---
Clay-(.005mm to .001mm)	---
Colloids-(Less than .001mm)	---
Total Silt/Clay/Colloids:	---

SPECIFIC GRAVITY: ASTM Method D854 ---

UNIT WEIGHT: Volumetric Method 122.7 pcf-wet
101.6 pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit ---
Plastic Limit ---
Plastic Index ---

PERCENT MOISTURE: ASTM Method D 2216-80 ---

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 ---

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SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-309-10A **Client I.D.:** GMW-7 SS-6

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size 4.7mm
Specific gravity if High 2.69 or Low ---
Hardness Soft and cohesive when wet.

Sieve Analysis

Grain size percentages and descriptions	**Percentages**
Gravel-(Retained on No. 4 Sieve; 4.75mm) Description:	---
Coarse sand-(Retained on No. 10 Sieve; 2.0mm) Description: Limestone fragments, angular	1
Medium sand-(Retained on No. 40 Sieve; 0.425mm) Description: Most quartz grains angular to rounded.	5
Fine Sand-(Retained on No. 200 Sieve; 0.075mm) Description: same as medium sand	20
Total Sand:	25

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	34
Clay-(.005mm to .001mm)	9
Colloids-(Less than .001mm)	32
Total Silt/Clay/Colloids:	75

SPECIFIC GRAVITY: ASTM Method D854 ---

UNIT WEIGHT: Volumetric Method --- pcf-wet
--- pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit ---
Plastic Limit ---
Plastic Index ---

PERCENT MOISTURE: ASTM Method D 2216-80 ---

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 ---

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SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-309-11A **Client I.D.:** GMW-7 SS-9

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size 4.7mm
Specific gravity if High --- or Low ---
Hardness Soft and cohesive when wet.

Sieve Analysis

Grain size percentages and descriptions	**Percentages**
Gravel-(Retained on No. 4 Sieve; 4.75mm)	---
Description:	
Coarse sand-(Retained on No. 10 Sieve; 2.0mm)	1
Description: Mostly chert, angular	
Medium sand-(Retained on No. 40 Sieve; 0.425mm)	3
Description: Mostly quartz-subrounded	
Fine Sand-(Retained on No. 200 Sieve; 0.075mm)	2
Description: Mostly quartz-subrounded	
Total Sand:	6

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	59
Clay-(.005mm to .001mm)	8
Colloids-(Less than .001mm)	27
Total Silt/Clay/Colloids:	94

SPECIFIC GRAVITY: ASTM Method D854 ---

UNIT WEIGHT: Volumetric Method 126.8 pcf-wet
103.6 pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit ---
Plastic Limit ---
Plastic Index ---

PERCENT MOISTURE: ASTM Method D 2216-80 ---

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 ---

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-309-31A **Client I.D.:** GMW-7 ST-1

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size 3.0mm
Specific gravity if High --- or Low ---
Hardness Soft, cohesive when wet.

Sieve Analysis

Grain size percentages and descriptions

	Percentages
Gravel-(Retained on No. 4 Sieve; 4.75mm) Description:	0
Coarse sand-(Retained on No. 10 Sieve; 2.0mm) Description: Angular chert fragments	1
Medium sand-(Retained on No. 40 Sieve; 0.425mm) Description: L.S. qtz., brown limonitic rock fragments, subangular.	2
Fine Sand-(Retained on No. 200 Sieve: 0.075mm) Description: Mostly quartz subangular.	9
Total Sand:	12

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	42
Clay-(.005mm to .001mm)	3
Colloids-(Less than .001mm)	43
Total Silt/Clay/Colloids:	88

SPECIFIC GRAVITY: ASTM Method D854 2.64 g/cm^3

UNIT WEIGHT: Volumetric Method 129 pcf-wet
108 pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit 55
Plastic Limit 18
Plastic Index 37

PERCENT MOISTURE: ASTM Method D 2216-80 24.6

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 46%

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-309-12A **Client I.D.:** GMW-8- SS-1

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size 10mm
Specific gravity if High --- or Low ---
Hardness Soft & cohesive when wet

Sieve Analysis

Grain size percentages and descriptions — **Percentages**

Gravel- (Retained on No. 4 Sieve; 4.75mm) — 20
Description: Limestone and slag

Coarse sand- (Retained on No. 10 Sieve; 2.0mm) — 20
Description: Limestone, white chert quartz-subangular.

Medium sand- (Retained on No. 40 Sieve; 0.425mm) — 17
Description: Mostly quartz

Fine Sand- (Retained on No. 200 Sieve; 0.075mm) — 11
Description:

Total Sand & Gravel: — 68

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	19
Clay-(.005mm to .001mm)	8
Colloids-(Less than .001mm)	5
Total Silt/Clay/Colloids:	32

SPECIFIC GRAVITY: ASTM Method D854 2.54 g/cm^3

UNIT WEIGHT: Volumetric Method --- pcf-wet
--- pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit ---
Plastic Limit ---
Plastic Index ---

PERCENT MOISTURE: ASTM Method D 2216-80 ---

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-309-32A **Client I.D.:** GMW-8- ST-1

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size 7.3mm
Specific gravity if High --- or Low 2.37
Hardness Soft & cohesive when wet

Sieve Analysis

Grain size percentages and descriptions — **Percentages**

Gravel-(Retained on No. 4 Sieve; 4.75mm) — 4
Description: Limestone fragments with asphalt film., angular.

Coarse sand-(Retained on No. 10 Sieve; 2.0mm) — 3
Description: Same as above with some quartz.

Medium sand-(Retained on No. 40 Sieve; 0.425mm) — 6
Description: Quartz, chert, angular, some asphalt film.

Fine Sand-(Retained on No. 200 Sieve; 0.075mm) — 13
Description:

Total Sand & Gravel: — 26

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	35
Clay-(.005mm to .001mm)	8
Colloids-(Less than .001mm)	31
Total Silt/Clay/Colloids:	74

SPECIFIC GRAVITY: ASTM Method D854 2.37 g/cm^3

UNIT WEIGHT: Volumetric Method 113.3 pcf-wet
100.3 pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit 44
Plastic Limit 16
Plastic Index 28

PERCENT MOISTURE: ASTM Method D 2216-80 15.7

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 51%

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-309-33A **Client I.D.:** GMW-9 ST-1

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size 3.2mm
Specific gravity if High --- or Low ---
Hardness Soft, cohesive when wet.

Sieve Analysis

Grain size percentages and descriptions	**Percentages**
Gravel-(Retained on No. 4 Sieve; 4.75mm) Description:	---
Coarse sand-(Retained on No. 10 Sieve; 2.0mm) Description: Limestone fragments and quartz-angular.	1
Medium sand-(Retained on No. 40 Sieve; 0.425mm) Description: Quartz, Subangular.	4
Fine Sand-(Retained on No. 200 Sieve; 0.075mm) Description: Quartz, angular	20
Total Sand:	25

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	35
Clay-(.005mm to .001mm)	11
Colloids-(Less than .001mm)	29
Total Silt/Clay/Colloids:	75

SPECIFIC GRAVITY: ASTM Method D854 ---

UNIT WEIGHT: Volumetric Method 117.9 pcf-wet
104.8 pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit 41
Plastic Limit 15
Plastic Index 26

PERCENT MOISTURE: ASTM Method D 2216-80 16.5%

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 37%

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-309-34A **Client I.D.:** GMW-10 ST-1

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size 1mm
Specific gravity if High --- or Low ---
Hardness Soft, cohesive when wet

Sieve Analysis

Grain size percentages and descriptions	Percentages
Gravel-(Retained on No. 4 Sieve; 4.75mm) Description:	0
Coarse sand-(Retained on No. 10 Sieve; 2.0mm) Description:	0
Medium sand-(Retained on No. 40 Sieve; 0.425mm) Description: Quartz, rounded grains	5
Fine Sand-(Retained on No. 200 Sieve; 0.075mm) Description: Quartz, some limonitic sand and black slag grains.	20
Total Sand:	25

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	35
Clay-(.005mm to .001mm)	11
Colloids-(Less than .001mm)	29
Total Silt/Clay/Colloids:	75

SPECIFIC GRAVITY: ASTM Method D854

UNIT WEIGHT: Volumetric Method 117.7 pcf-wet
104.6 pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit 39
Plastic Limit 16
Plastic Index 23

PERCENT MOISTURE: ASTM Method D 2216-80 17.2%

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 40%

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-309-13A **Client I.D.:** GMW-11 SS-1

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size 2.8mm
Specific gravity if High ______ or Low ______
Hardness Soft and cohesive when wet

Sieve Analysis

Grain size percentages and descriptions — **Percentages**

Grain size	Percentages
Gravel-(Retained on No. 4 Sieve; 4.75mm) Description:	---
Coarse sand-(Retained on No. 10 Sieve; 2.0mm) Description: Mostly subrounded limestone	1
Medium sand-(Retained on No. 40 Sieve; 0.425mm) Description: Mostly subrounded limestone, and limonitic grains, some quartz	1
Fine Sand-(Retained on No. 200 Sieve; 0.075mm) Description: Same as above	1
Total Sand:	3

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	64
Clay-(.005mm to .001mm)	10
Colloids-(Less than .001mm)	23
Total Silt/Clay/Colloids:	97

SPECIFIC GRAVITY: ASTM Method D854 ______

UNIT WEIGHT: Volumetric Method 125.1 pcf-wet
101.9 pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit ---
Plastic Limit ---
Plastic Index ---

PERCENT MOISTURE: ASTM Method D 2216-80 ---

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 ---

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-309-39A **Client I.D.:** GMW-11 ST-1

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size 2.8mm
Specific gravity if High --- or Low ---
Hardness Soft and cohesive when wet.

Sieve Analysis

Grain size percentages and descriptions — **Percentages**

Gravel-(Retained on No. 4 Sieve; 4.75mm) ______
Description: ______

Coarse sand-(Retained on No. 10 Sieve; 2.0mm) 1
Description: There was only 0.2% coarse sand; one subangular limestone grain.

Medium sand-(Retained on No. 40 Sieve; 0.425mm) 3
Description: Mostly subangular to subrounded quartz with trace limestone and limonite grains.

Fine Sand-(Retained on No. 200 Sieve; 0.075mm) 15
Description: Same as above

Total Sand: 18

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

	Percentages
Silt-(.074mm to .005mm)	31
Clay-(.005mm to .001mm)	10
Colloids-(Less than .001mm)	41
Total Silt/Clay/Colloids:	82

SPECIFIC GRAVITY: ASTM Method D854 2.55 g/cm^3

UNIT WEIGHT: Volumetric Method 129.7 pcf-wet
105.5 pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit 58
Plastic Limit 14
Plastic Index 44

PERCENT MOISTURE: ASTM Method D 2216-80 23.3%

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 41%

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-310-06A **Client I.D.:** GMW-12-ST-1

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size 25mm
Specific gravity if High --- or Low ---
Hardness Soft and cohesive when wet.

Sieve Analysis

Grain size percentages and descriptions	**Percentages**
Gravel-(Retained on No. 4 Sieve; 4.75mm) Description: 3/4" Claystone. No. 4 claystone and chert, angular.	10
Coarse sand-(Retained on No. 10 Sieve; 2.0mm) Description: Chert, angular	2
Medium sand-(Retained on No. 40 Sieve; 0.425mm) Description: Quartz and chert	5
Fine Sand-(Retained on No. 200 Sieve; 0.075mm) Description: Quartz with some chert subrounded limonitic grains.	7
Total Sand & Gravel:	24

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	63
Clay-(.005mm to .001mm)	2
Colloids-(Less than .001mm)	11
Total Silt/Clay/Colloids:	76

SPECIFIC GRAVITY: ASTM Method D854 2.59 g/cm^3

UNIT WEIGHT: Volumetric Method 99.9 pcf-wet
73.3 pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit 50
Plastic Limit 18
Plastic Index 32

PERCENT MOISTURE: ASTM Method D 2216-80 25.7%

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 ---

10/86

SOILS ANALYSIS
CHEMICAL TEST

Sample Number: 8609310-06A **Client I.D.:** GMW-12 ST-1

CATION EXCHANGE CAPACITY; Hoddinott Method

Exchange Acidity, meq/100g o.d. soil = 27.63

Exchange Cation Content, meq/100g o.d. soil **(Ca) =** 24.09

(Mg) = 7.54

(K) = 0.42

(Na) = 0.52

ECEC = effective cation exchange capacity, meq/100g o.d. soil.

ECEC = 60.2

DISTRIBUTION RATIOS; Method D-4320-84 - See separate report.

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-309-14A **Client I.D.:** GMW-13 SS-4

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size ---
Specific gravity if High --- or Low ---
Hardness ---

Sieve Analysis

Grain size percentages and descriptions — **Percentages**

Grain size percentages and descriptions	Percentages
Gravel-(Retained on No. 4 Sieve; 4.75mm) Description:	---
Coarse sand-(Retained on No. 10 Sieve; 2.0mm) Description:	---
Medium sand-(Retained on No. 40 Sieve; 0.425mm) Description:	---
Fine Sand-(Retained on No. 200 Sieve; 0.075mm) Description:	---
Total Sand:	---

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	---
Clay-(.005mm to .001mm)	---
Colloids-(Less than .001mm)	---
Total Silt/Clay/Colloids:	---

SPECIFIC GRAVITY: ASTM Method D854 2.68 g/cm^3

UNIT WEIGHT: Volumetric Method --- pcf-wet
--- pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit ---
Plastic Limit ---
Plastic Index ---

PERCENT MOISTURE: ASTM Method D 2216-80 ---

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 ---

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-310-07A **Client I.D.:** GMW-13 ST-1

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size 0.5mm
Specific gravity if High --- or Low ---
Hardness Soft and cohesive when wet.

Sieve Analysis

Grain size percentages and descriptions — **Percentages**

Gravel-(Retained on No. 4 Sieve; 4.75mm) ---
Description:

Coarse sand-(Retained on No. 10 Sieve; 2.0mm) ---
Description:

Medium sand-(Retained on No. 40 Sieve; 0.425mm) 1
Description: Subangular and subrounded limestone quartz, and limonitic grains.

Fine Sand-(Retained on No. 200 Sieve; 0.075mm) 6
Description: Mostly angular quartz, some subrounded limestone and limonitic grains.

Total Sand: 7

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	48
Clay-(.005mm to .001mm)	8
Colloids-(Less than .001mm)	37
Total Silt/Clay/Colloids:	93

SPECIFIC GRAVITY: ASTM Method D854 2.66 g/cm^3

UNIT WEIGHT: Volumetric Method 121.4 pcf-wet
101.9 pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit 45
Plastic Limit 17
Plastic Index 28

PERCENT MOISTURE: ASTM Method D 2216-80 23.8

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 ---

10/86

SOILS ANALYSIS
CHEMICAL TEST

Sample Number: 8609310-07A **Client I.D.:** GMW-13 ST-1

CATION EXCHANGE CAPACITY; Hoddinott Method

Exchange Acidity, meq/100g o.d. soil = 32.42

Exchange Cation Content, meq/100g o.d. soil

(Ca) =	17.84
(Mg) =	8.92
(K) =	0.25
(Na) =	1.01

ECEC = effective cation exchange capacity, meq/100g o.d. soil.

ECEC = 60.4

DISTRIBUTION RATIOS; Method D-4320-84 - See separate report.

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-309-40A **Client I.D.:** GMW-14-ST-1

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size 4.0mm
Specific gravity if High --- or Low ---
Hardness Soft and cohesive when wet.

Sieve Analysis

Grain size percentages and descriptions — **Percentages**

Gravel-(Retained on No. 4 Sieve; 4.75mm) ---
Description:

Coarse sand-(Retained on No. 10 Sieve; 2.0mm) 1
Description: Mostly subangular chert, quartz grains, some limestone possibly dolomite.

Medium sand-(Retained on No. 40 Sieve; 0.425mm) 3
Description: Same as above, also some subrounded limonitic grains scattered.

Fine Sand-(Retained on No. 200 Sieve; 0.075mm) 12
Description: Same as above

Total Sand: 16

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	32
Clay-(.005mm to .001mm)	15
Colloids-(Less than .001mm)	42
Total Silt/Clay/Colloids:	84

SPECIFIC GRAVITY: ASTM Method D854 2.68 g/cm^3

UNIT WEIGHT: Volumetric Method 121.5 pcf-wet
98.2 pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit 53
Plastic Limit 14
Plastic Index 39

PERCENT MOISTURE: ASTM Method D 2216-80 23.3%

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 45%

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-309-15A **Client I.D.:** GMW-15 SS-1

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size 3.0mm
Specific gravity if High --- or Low ---
Hardness Soft, cohesive when wet.

Sieve Analysis

Grain size percentages and descriptions | **Percentages**

Grain size percentages and descriptions	Percentages
Gravel-(Retained on No. 4 Sieve; 4.75mm) Description:	0
Coarse sand-(Retained on No. 10 Sieve; 2.0mm) Description: Mostly argillite fragments some quartz, subrounded.	Trace
Medium sand-(Retained on No. 40 Sieve; 0.425mm) Description: Same as above	1
Fine Sand-(Retained on No. 200 Sieve; 0.075mm) Description: Same as above	2
Total Sand:	3

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	59
Clay-(.005mm to .001mm)	7
Colloids-(Less than .001mm)	31
Total Silt/Clay/Colloids:	97

SPECIFIC GRAVITY: ASTM Method D854 ---

UNIT WEIGHT: Volumetric Method 92.8 pcf-wet; 86.6 pcf-dry

sample arrived partly dried and in small volume so results may differ from those obtained from wetter, larger sample

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit ---
Plastic Limit ---
Plastic Index ---

PERCENT MOISTURE: ASTM Method D 2216-80 ---

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 ---

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-309-19A **Client I.D.:** GMW-18 SS-1

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size 12mm
Specific gravity if High 2.72 or Low ---
Hardness Soft & cohesive when wet

Sieve Analysis

Grain size percentages and descriptions — **Percentages**

Gravel-(Retained on No. 4 Sieve; 4.75mm) — 9%
Description: Limestone pebbles

Coarse sand-(Retained on No. 10 Sieve; 2.0mm) — 4
Description: Brown limonitic spheres, L.S. and quartz.

Medium sand-(Retained on No. 40 Sieve; 0.425mm) — 2
Description: Same as above

Fine Sand-(Retained on No. 200 Sieve; 0.075mm) — 2
Description:

Total Sand & Gravel: — 17

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm) — 49
Clay-(.005mm to .001mm) — 7
Colloids-(Less than .001mm) — 27
Total Silt/Clay/Colloids: — 83

SPECIFIC GRAVITY: ASTM Method D854 ---

UNIT WEIGHT: Volumetric Method --- pcf-wet
--- pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit ---
Plastic Limit ---
Plastic Index ---

PERCENT MOISTURE: ASTM Method D 2216-80 ---

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 ---

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-309-20A **Client I.D.:** GMW-18 SS-2

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size ---
Specific gravity if High --- or Low ---
Hardness ______

Sieve Analysis

Grain size percentages and descriptions **Percentages**

Gravel-(Retained on No. 4 Sieve; 4.75mm) ---
Description: ______

Coarse sand-(Retained on No. 10 Sieve; 2.0mm) ---
Description: ______

Medium sand-(Retained on No. 40 Sieve; 0.425mm) ---
Description: ______

Fine Sand-(Retained on No. 200 Sieve; 0.075mm) ---
Description: ______

Total Sand: ---

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm) ---
Clay-(.005mm to .001mm) ---
Colloids-(Less than .001mm) ---
Total Silt/Clay/Colloids: ---

SPECIFIC GRAVITY: ASTM Method D854 2.67 g/cm^3

UNIT WEIGHT: Volumetric Method --- pcf-wet
--- pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit ---
Plastic Limit ---
Plastic Index ---

PERCENT MOISTURE: ASTM Method D 2216-80 ---

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 ---

10/86

SOILS ANALYSIS
PHYSICAL TEST

Sample Number: 86-09-310-08A **Client I.D.:** GMW-18 ST-1

PARTICLE SIZE ANALYSIS; ASTM Method D422

Maximum Particle Size 4.0mm
Specific gravity if High --- or Low ---
Hardness Soft and cohesive when wet.

Sieve Analysis

Grain size percentages and descriptions — **Percentages**

Gravel-(Retained on No. 4 Sieve; 4.75mm) Description:	---
Coarse sand-(Retained on No. 10 Sieve; 2.0mm) Description: Angular to subangular chert quartz	1
Medium sand-(Retained on No. 40 Sieve; 0.425mm) Description: Subangular to subrounded chert and quartz.	4
Fine Sand-(Retained on No. 200 Sieve; 0.075mm) Description: Mostly subangular quartz	15
Total Sand:	20

Hydrometer Analysis

Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.

Silt-(.074mm to .005mm)	32
Clay-(.005mm to .001mm)	9
Colloids-(Less than .001mm)	39
Total Silt/Clay/Colloids:	80

SPECIFIC GRAVITY: ASTM Method D854 2.55 g/cm^3

UNIT WEIGHT: Volumetric Method 112.2 pcf-wet
105.2 pcf-dry

ATTERBERG TESTS: ASTM Method D4318-84

Liquid Limit 55
Plastic Limit 16
Plastic Index 39

PERCENT MOISTURE: ASTM Method D 2216-80 21.7%

CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 ---

10/86

SOILS ANALYSIS
CHEMICAL TEST

Sample Number: 8609310-08A **Client I.D.:** GMW-18 ST-1

CATION EXCHANGE CAPACITY; Hoddinott Method

Exchange Acidity, meq/100g o.d. soil = 42.12

Exchange Cation Content, meq/100g o.d. soil **(Ca)** = 21.86

(Mg) = 11.84

(K) = 0.36

(Na) = 1.13

ECEC = effective cation exchange capacity, meq/100g o.d. soil.

ECEC = 77.3

DISTRIBUTION RATIOS; Method D-4320-84 - See separate report.

DISTRIBUTION RATIOS BY THE SHORT-TERM BATCH METHOD

CEP obtained five soil core samples from Bechtel Corporation for testing of distribution ratios by the short-term batch method. This is ASTM Standard Test Method D4319-83. This is a measurement technique for determining the distribution ratio or degree of partitioning between the soil and a water solution containing the species of interest. The species of interest for this case was uranium. Several repetitions of this test were performed before one optimium uranium concentration was established. The results presented are for that concentration of uranium (10 mg/l). In addition, the chemical constituents leached from the soils on the first day of the test are also included.

Method

ASTM Method D4319-83 briefly consists of setting up a series of batch reactions between the soil to be tested and a contacting liquid containing the species of interest. The soil samples are pre-washed and treated if necessary and then mixed with the contact solution in a ratio of 4 parts solution to 1 part soil. Over a time period of 14 days or longer, the batch samples are analyzed for the concentration of the species of interest, the initial chemical constituents of the leach solution and a series of chemical parameters for determining the equilibrium conditions of the test. In this case, the samples were analyzed repeatedly for pH, Eh, and specific conductivity.

These are the results for the prepared batch samples. The sample identifications are as follows:

CEP #	Bechtel Identification		
8609310 - 5A	GMW-2	ST-1	11.5-12.5
8609310 - 6A	GMW-12	ST-1	10.0-11.5
8609310 - 7A	GMW-13	ST-1	11.5-13.5
8609310 - 8A	GMW-18	ST-1	11.5-13.5
8609310 - 9A	G-21	ST-1	16.5-18.5

Free Uranium

Sample #	Dates: 11/27	12/4	12/9	12/16
8609310 - 5A	0.423 mg/l	0.169	0.174	0.200
8609310 - 6A	0.872	1.518	0.288	0.809
8609310 - 7A	0.2209	1.391	0.654	0.636
8609310 - 8A	1.585	1.508	1.256	1.237
8609310 - 9A	0.881	1.147	0.348	0.981
Leach Sln.	10.440	10.540		

Eh

Sample #	Dates: 11/25	12/2	12/8	12/15
8609310 - 5A	+228 mv	277	389	424
8609310 - 6A	162	253	366	413
8609310 - 7A	178	260	383	419
8609310 - 8A	158	232	341	403
8609310 - 9A	127	204	321	385
Leach Sln.	110	287	336	391

pH

Sample #	Dates: 11/25	12/2	12/8	12/15
8609310 - 5A	7.79	7.00	7.02	7.20
8609310 - 6A	8.73	7.59	7.67	7.86
8609310 - 7A	8.58	7.08	7.20	7.30
8609310 - 8A	9.13	7.75	7.77	8.20
8609310 - 9A	272	306	335	341
Leach Sln.	7.65	7.35	7.31	7.10

Specific Conductivity

Sample #	Dates: 11/26	12/2	12/8	12/15
8609310 - 5A	332 umhos/cm	388	409	445
8609310 - 6A	287	341	363	393
8609310 - 7A	307	407	437	455
8609310 - 8A	282	331	372	383
8609310 - 9A	272	306	335	341
Leach Sln.	262	256	251	270

Test Conditions

Contact liquid (Leach Sln.): Deionized water containing 10 mg/l uranium

Initial pH: 7.65 Final pH: 7.10

Solid to liquid ratio: 200 grams soil/800 mls sln.

Contact time: 21 days

Equilibrating atmosphere: air

Contact solution filtered after centrifugation?: no

Soil sampe disaggregated?: yes

Particle size: approximately 5mm

H_2O_2treatment to remove organics?: no

Samples were mixed for six hours by rotation between analyses.

Additional data on the leached solution chemical parameters is shown under a separate report for CEP #8612233.

Distribution Ratio

$$R_d = \frac{(F_m)(V_s)}{(F_s)(W_m)}$$

where:

R_d= distribution ratio, mL/g

F_s= fraction of total activity in solution.

F_s is found by dividing the the concentrations of the ion after the solution has come to equilibrium with the soil/rock fraction by the concentration of the ion before the solution was allowed to come to equilibrium with the soil fraction.

F_m = fraction of activity sorbed into the solid residue.

$$F_m = 1 - F_s$$

V_s = volume of solution equilibrated with W_m, ml

W_m = weight of solid residue, g

Sample Values

8609310 - 5A

$$R_d = \frac{(F_m)(V_s)}{(F_s)(W_m)}$$

$$F_s = \frac{0.200 \text{ mg/l}}{10.440 \text{ mg/l}} = 0.0192$$

$$F = 1 - 0.0192 = 0.98$$

V_s = 800 mls leach solution
W_m = 200 grams solid

$$R_d = \frac{(0.98)(800\text{ml})}{(0.019)(200\text{g})} = 207 \text{ ml/g}$$

8609310 - 6A

$$R_d = \frac{(0.939)(800 \text{ ml})}{(0.077)(200\text{g})} = 47.7 \text{ ml/g}$$

8609310 - 7A

$$R_d = \frac{(0.939)\ 800 \text{ ml})}{(1.061)(200\text{g})} = 61.6 \text{ ml/g}$$

8609310 - 8A

$$R_d = \frac{(0.906)(800 \text{ ml})}{(0.118)(200\text{g})} = 29.9 \text{ ml/g}$$

8609310 - 9A

$$R_d = \frac{(0.906)(800 \text{ ml})}{(0.094)(200\text{g})} = 38.6 \text{ ml/g}$$

Analytical Methods

Calcium	EPA	200.7
Chloride	EPA	325.2
Iron	EPA	200.7
Potassium	EPA	258.1
Magnesium	EPA	200.7
Manganese	EPA	200.7
Sodium	EPA	273.1
Sulfate	EPA	375.4
Solids, Total Dissolved	EPA	160.1
Total alkalivity (as $CaCo_3$)	EPA	310.1
ph	EPA	150.1
Eh	ASTM D1498-76	
Specific Conductance	EPA	120.1
Uranium	ASTM D2907-75	

PAGE 1 CEP, Inc. REPORT LAB # 86-12-233

RECEIVED: 12/15/86 01/06/87 09:46:19

REPORT TO Bechtel
P.O. Box 350
Oak Ridge, TN 37831-0350

ATTEN Mark Tardiff

CLIENT BECHTEL SAMPLES 6
COMPANY Bechtel
FACILITY 800 Oak Ridge Turnpike

PREPARED BY Controls for Environmental Pollution, Inc.
1925 Rosina Street
Santa Fe, NM 87502

ATTEN
PHONE (505) 982-9841

CERTIFIED BY

CONTACT GAIL

These samples will be disposed of in three weeks from the date of final report unless other arrangements are made.

WORK ID Water Quality
TAKEN
TRANS Relog
TYPE Water
P.O. #
INV. # 419612

D-67

SAMPLE IDENTIFICATION

01	GMW-? ST-1 11.5-12.5
02	GMW-12 ST-1 10.0-11.5
03	GMW-13 ST-1 11.5-13.5
04	GMW-18 ST-1 11.5-13.5
05	G-21 St-1 16.5-18.5
06	Blank

CEP, Inc. TEST CODES and NAMES used on this report

CA 1	Calcium
CL 1	Chloride
FE 1	Iron
K 1	Potassium
MG 1	Magnesium
MN 1	Manganese
NA 1	Sodium
SO4 W	Sulfate
TDS 1	Total Dissolved Solids
T ALK1	Total Alkalinity(as CaCO3)

REPORT ANALYSIS

LAB # 86-12-2[illegible]

SAMPLE IDENTIFICATION	DATE COLLECTED	TYPE OF ANALYSIS	mg/liter
GMW-2 ST-1 11.5-12.5	not specified	Calcium	15.9
		Chloride	2
		Iron	6.50
		Potassium	5.3
		Magnesium	3.0
		Manganese	0.77
		Sodium	7.8
		Sulfate	17
		Solids, Total Dissolved	208
		Total Alkalinity (as CaCO3)	15
GMW-12 ST-1 10.0-11.5	not specified	Calcium	22.9
		Chloride	2
		Iron	2.35
		Potassium	2.9
		Magnesium	2.4
		Manganese	0.08
		Sodium	6.6
		Sulfate	3
		Solids, Total Dissolved	160
		Total Alkalinity (as CaCO3)	25
GMW-13 ST-1 11.5-13.5	not specified	Calcium	10.6
		Chloride	1
		Iron	2.52
		Potassium	1.8
		Magnesium	1.6
		Manganese	0.04
		Sodium	10.6
		Sulfate	3
		Solids, Total Dissolved	173
		Total Alkalinity (as CaCO3)	27
GMW-18 ST-1 11.5-13.5	not specified	Calcium	12.2
		Chloride	<1
		Iron	2.27
		Potassium	2.2
		Magnesium	2.3
		Manganese	0.02

OUT OF STATE 800/545-2188

REPORT OF ANALYSIS

LAB # 86-12-2??

SAMPLE IDENTIFICATION	DATE COLLECTED	TYPE OF ANALYSIS	mg/liter
GMW-18 ST-1 11.5-13.5	(Con't)	Sodium	13.4
		Sulfate	<1
		Solids, Total Dissolved	148
		Total Alkalinity (as $CaCO_3$)	29
G-21 St-1 16.5-18.5	not specified	Calcium	11.8
		Chloride	1
		Iron	5.73
		Potassium	3.3
		Magnesium	1.8
		Manganese	0.04
		Sodium	13.5
		Sulfate	<1
		Solids, Total Dissolved	148
		Total Alkalinity (as $CaCO_3$)	44
Blank	not specified	Calcium	<0.1
		Chloride	1
		Iron	<0.01
		Potassium	<1.0
		Magnesium	<1.0
		Manganese	<0.01
		Sodium	<1.0
		Sulfate	<1
		Solids, Total Dissolved	16
		Total Alkalinity (as $CaCO_3$)	2

APPENDIX E

ELECTROMAGNETIC TERRAIN CONDUCTIVITY SURVEY OF THE WELDON SPRING CHEMICAL PLANT GROUNDS

APPENDIX E
ELECTROMAGNETIC TERRAIN CONDUCTIVITY SURVEY OF THE WELDON SPRING CHEMICAL PLANT GROUNDS

1.0 INTRODUCTION AND PURPOSE

An Electromagnetic (EM) Terrain Conductivity Survey was performed at the Weldon Spring Site in February 1986 to identify the presence of conductive contaminant plumes in the site groundwater system and thereby provide information on which to base the selection of locations for groundwater monitoring wells.

2.0 LOCATION AND SURVEY CONTROL

Figure E-1 is a terrain conductivity contour map showing the areal limits of the survey. Initial horizontal control for the survey was established by the compass and line-of-sight methods. The survey lines were marked at each end (and at turning points where appropriate) by stakes which were subsequently surveyed relative to site coordinates.

3.0 METHOD OF INVESTIGATION

The survey was performed using the Model EM 34-3 electromagnetic terrain conductivity meter manufactured by Geonics Limited of Ontario, Canada.

Conductivity data were obtained at a series of traverses concentrated in three areas at the site: the Ash Pond, the area to the north of the Weldon Spring Chemical Plant (WSCP), and the area to the east of the WSCP. Surveying of the WSCP property was prevented by electrical interference generated by power lines, overhead and underground metallic pipes, and metallic structures.

The instrumentation was placed in the horizontal dipole mode (vertical coil configuration) with an intercoil spacing of 20 m. The optimum intercoil spacing was determined on the basis of depth to groundwater as measured in geologic boreholes in the WSCP area. The 20-m intercoil was used to provide an exploration depth of 15 to 18 m.

4.0 RESULTS AND INTERPRETATION

The results of the conductivity survey are presented in Figure E-1. Results of the survey are discussed separately for each of the three distinct areas referenced above (the Ash Pond and the areas to the north and to the east of the WSCP).

4.1 ASH POND AREA

Contours in the Ash Pond area show generally low to moderate conductivity values, with the exception of four localized areas of high conductivity. The two areas of high conductivity in the central and southern central portions of the Ash Pond appear to be related to completely or partially buried metallic debris, including drums and scrap metal. The third area, located to the west of the Ash Pond, is an expression of the buried discharge line that conducts water from the Ash Pond to a surface drainage channel. The fourth area of high conductivity, located north of the Ash Pond, is an expression of a buried culvert. In general, terrain conductivities increase from southwest to northeast: the approximate direction of groundwater flow in the area.

4.2 NORTH OF WSCP

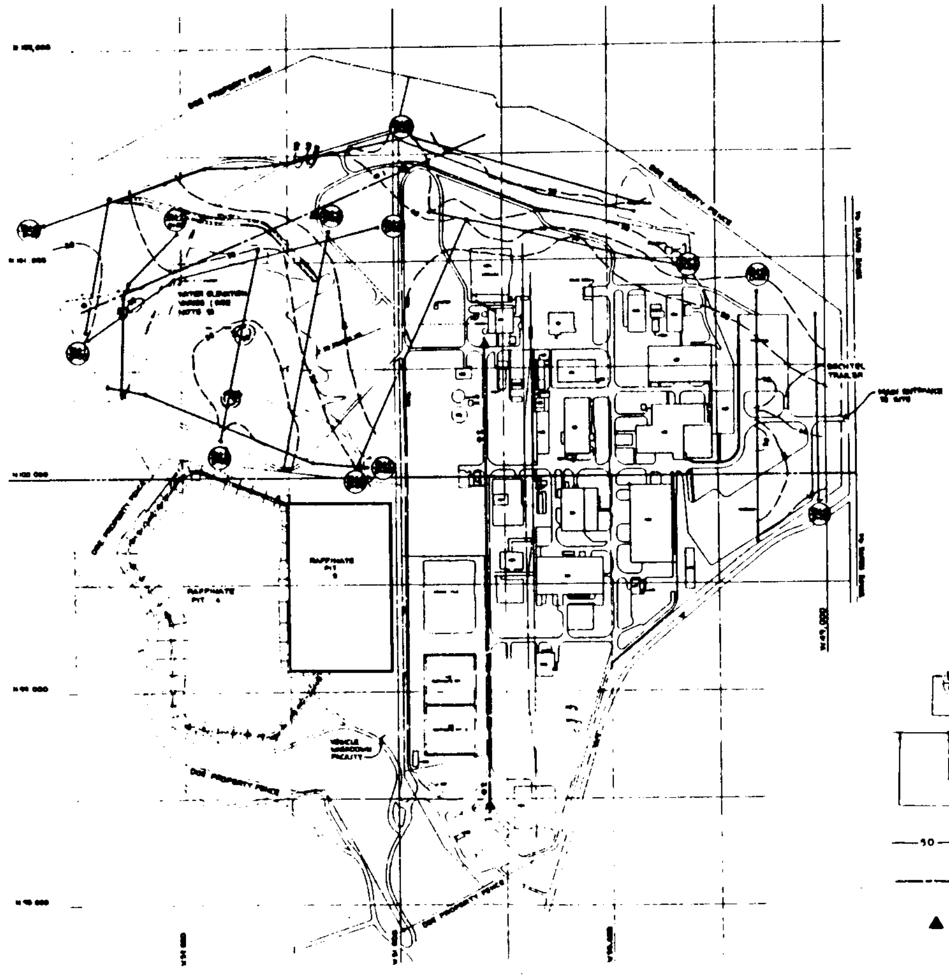
Conductivities in the area to the north of the WSCP tend to decrease from south to north. While conductivities in the extreme northern portion of this area are among the lowest recorded at the site, the area immediately adjacent to the chemical plant exhibits the highest conductivity values. The 50-mmhos/m contour, which appears to characterize the area occupied by the chemical plant, may indicate an area of degraded groundwater quality. The installation and sampling of groundwater monitoring wells.in this area will provide the information necessary to evaluate this hypothesis.

4.3 EAST OF WSCP

The area to the east of the WSCP exhibited the highest average conductivity of the three areas surveyed. The southern portion of this area exhibited conductivity values in excess of 60 mmhos/m. The distribution of the high conductivity zone along line EM-10 indicates two narrow areas of high conductivity, while the distribution along line EM-11 indicates a broader area of high conductivity. Based upon the geology of the area, it is possible that the high readings may be an expression of a solution feature.

5.0 RECOMMENDATIONS

It is recommended that two monitoring wells be relocated to provide additional data from the area of high conductivity to the east of the WSCP. The existing design locations of monitoring wells to the north of the WSCP are adequate to evaluate the potential for contamination of the groundwater in this area. A review of the site configuration, interferences, and directions of groundwater flow leads to the recommendation that additional electromagnetic terrain conductivity surveys are not needed at this time.



EM-6 (0-00) STARTING STATION

SURVEY LINE NUMBER

DASHED WHERE CROSSING FENCE

LOCATION SURVEY STATION (COORDINATES ONLY)

ELECTROMAGNETIC TERRAIN CONDUCTIVITY SURVEY LINE

—— 10 —— TERRAIN CONDUCTIVITY CONTOUR, CONTOUR INTERVAL = 10 MILLIMHOS/M

SHALLOW REFRACTION SURVEY (APPROX 4200 FEET)

▲ GEOLOGIC BOREHOLE (BY OTHERS)

GENERAL NOTES

1. GEOPHYSICAL SURVEYS SHALL BE PER SPECIFICATION 201-23-C-01.
2. LOCATIONS SHOWN FOR GEOPHYSICAL SURVEYS ARE APPROXIMATE. EXACT LOCATIONS WILL BE DETERMINED IN THE FIELD BY BECHTEL.
3. THE GREATEST DEPTH OF OVERBURDEN IS APPROXIMATELY 65 FEET.
4. GEOPHYSICAL SURVEYS SHALL BE DISCONTINUED AT FENCE LINES AND RESUMED AT OPPOSITE SIDE OF FENCE. FENCE SHALL NOT BE DISTURBED.
5. GEOPHYSICAL SURVEYS WILL NOT BE REQUIRED IN AREAS OF STANDING WATER.
6. EM SURVEY WAS PERFORMED WITH A GEONICS EM 34-3 INSTRUMENT.
7. EM SURVEY WAS PERFORMED USING HORIZONTAL COPLANAR DIPOLE CONFIGURATION WITH A 20 METER INTERCOIL SPACING.
8. FOR AS BUILT INFORMATION ON THE SHALLOW SEISMIC REFRACTION SURVEY, SEE THE SUBCONTRACTOR'S REPORT.

FIGURE E-1 TERRAIN CONDUCTIVITY CONTOUR MAP SHOWING AREAL LIMITS OF THE SURVEY

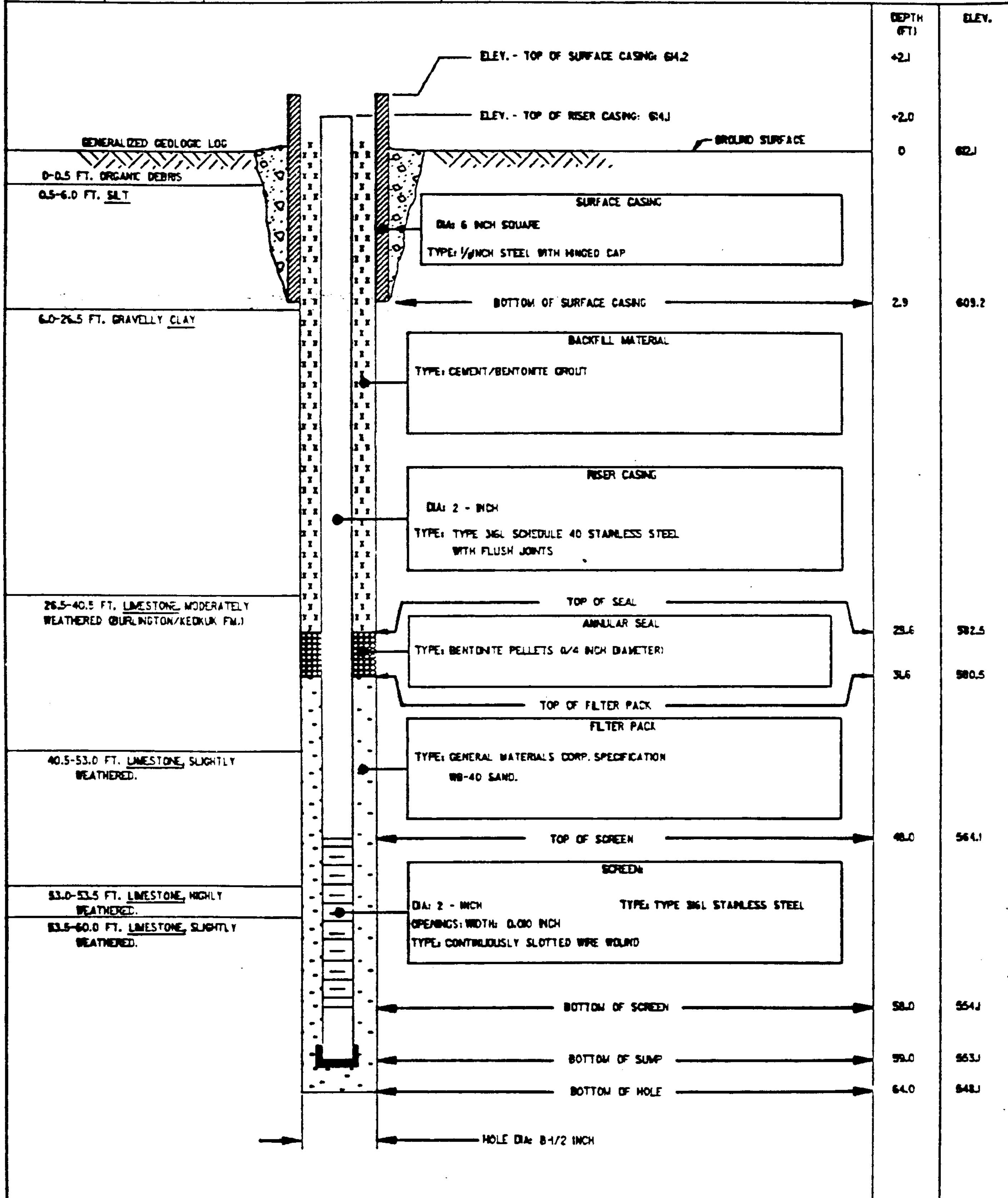
APPENDIX F
WELL CONSTRUCTION DATA

MONITORING WELL

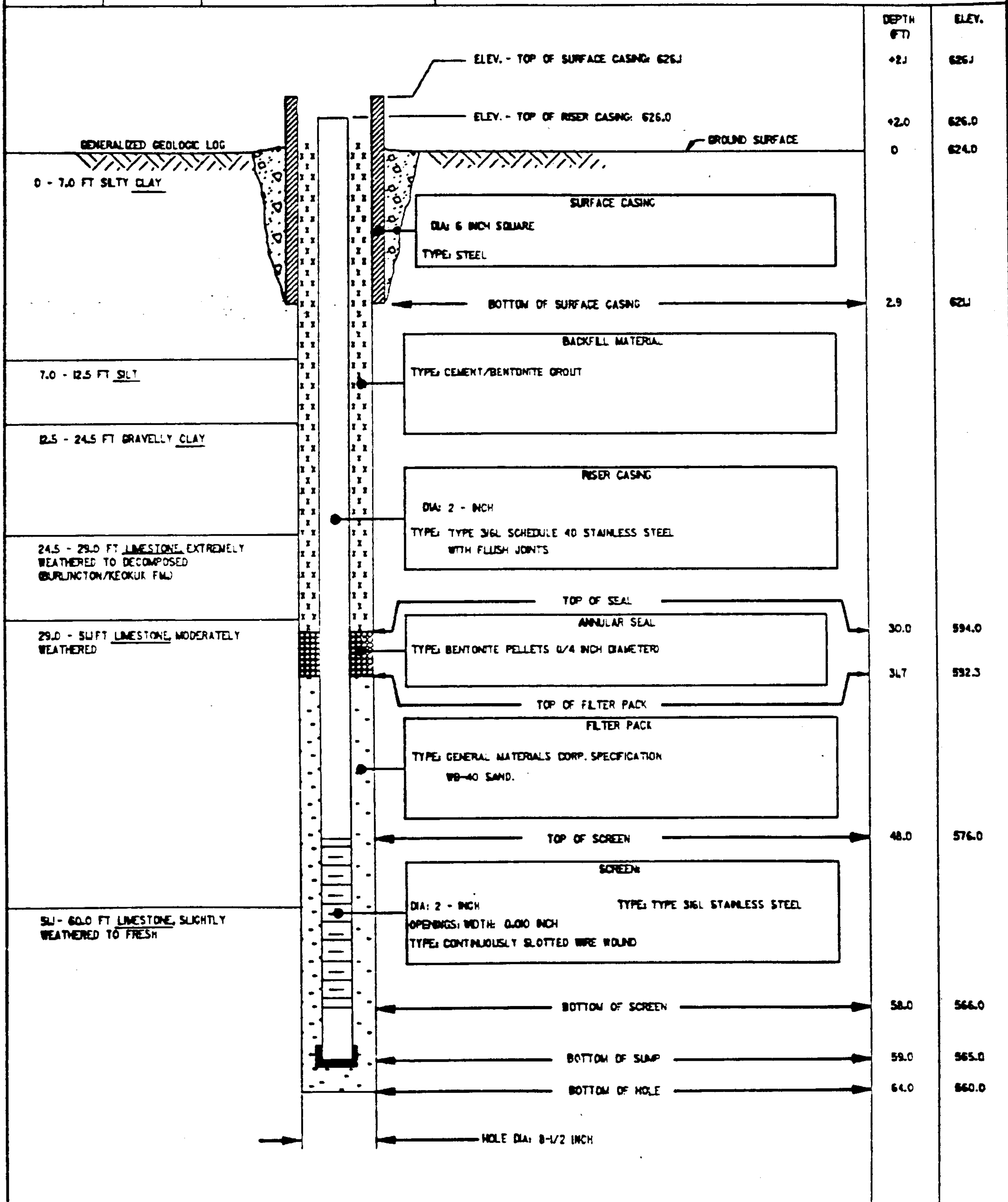
PROJECT	WELL NO.
FUSRAP - WELDON SPRING CHEMICAL PLANT	GMW-1

JOB NO.	SITE	COORDINATES
14501	WEST OF ASH POND	N100,858 W52,554

BEGUN	COMPLETED	PREPARED BY	REFERENCE POINT FOR MEASUREMENTS
7/23/86	7/23/86	E. BERGLUND	GROUND SURFACE



MONITORING WELL	PROJECT: FUSRAP - WELDON SPRING CHEMICAL PLANT		WELL NO.: GMW-2A
JOB NO.: 14501	SITE: WEST SIDE OF ASH POND	COORDINATES: N100,658 W52,253	
BEGUN: 7/22/86	COMPLETED: 7/22/86	PREPARED BY: E.BERGLUND	REFERENCE POINT FOR MEASUREMENTS: GROUND SURFACE

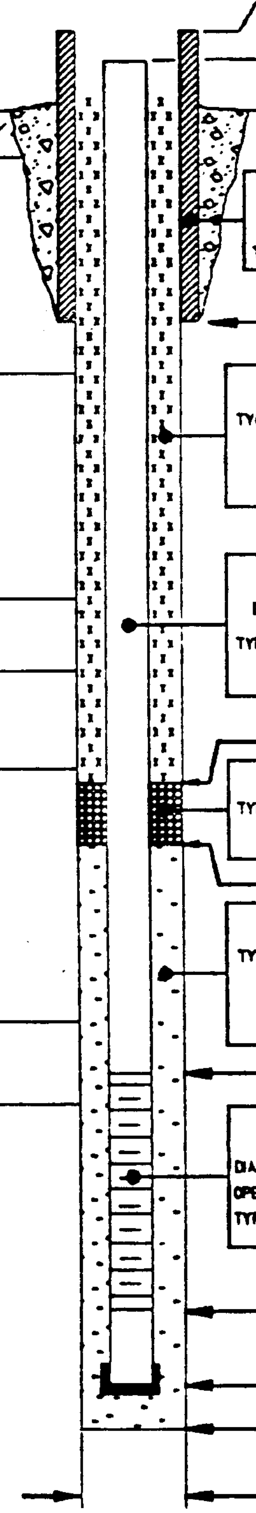


MONITORING WELL

PROJECT	WELL NO.
FUSRAP - WELDON SPRING CHEMICAL PLANT	GMW-3

JOB NO.	SITE	COORDINATES
14501	SOUTHWEST OF ASH POND	N100,347 W52,299

BEGUN	COMPLETED	PREPARED BY	REFERENCE POINT FOR MEASUREMENTS
7/21/86	7/21/86	E.BERGLUND	GROUND SURFACE



GENERALIZED GEOLOGIC LOG

0 - 1.0 FT GRAVEL

1.0 - 8.0 FT SILT

8.0 - 22.0 FT CLAY

22.0 - 28.0 FT GRAVELLY CLAY

28.0 - 38.8 FT LIMESTONE, DECOMPOSED (BURLINGTON / KEOKUK FM)

38.8 - 45.6 FT LIMESTONE, MODERATELY WEATHERED

45.6 - 48.5 FT LIMESTONE, EXTREMELY WEATHERED

48.5 - 59.0 FT LIMESTONE, SLIGHTLY WEATHERED

	DEPTH (FT)	ELEV.
ELEV. - TOP OF SURFACE CASING: 638.9	+2.1	
ELEV. - TOP OF RISER CASING: 638.8	+2.0	
GROUND SURFACE	0.0	636.8
BOTTOM OF SURFACE CASING	2.9	633.9
TOP OF SEAL	39.3	597.5
TOP OF FILTER PACK	41.5	595.3
TOP OF SCREEN	48.0	588.8
BOTTOM OF SCREEN	58.0	578.8
BOTTOM OF SUMP	59.0	577.8
BOTTOM OF HOLE	64.0	572.8

SURFACE CASING
DIA: 6 INCH SQUARE
TYPE: 1/4 INCH STEEL WITH HINGED CAP

BACKFILL MATERIAL
TYPE: CEMENT/BENTONITE GROUT

RISER CASING
DIA: 2 - INCH
TYPE: TYPE 316L SCHEDULE 40 STAINLESS STEEL WITH FLUSH JOINTS

ANNULAR SEAL
TYPE: BENTONITE PELLETS (1/4 INCH DIAMETER)

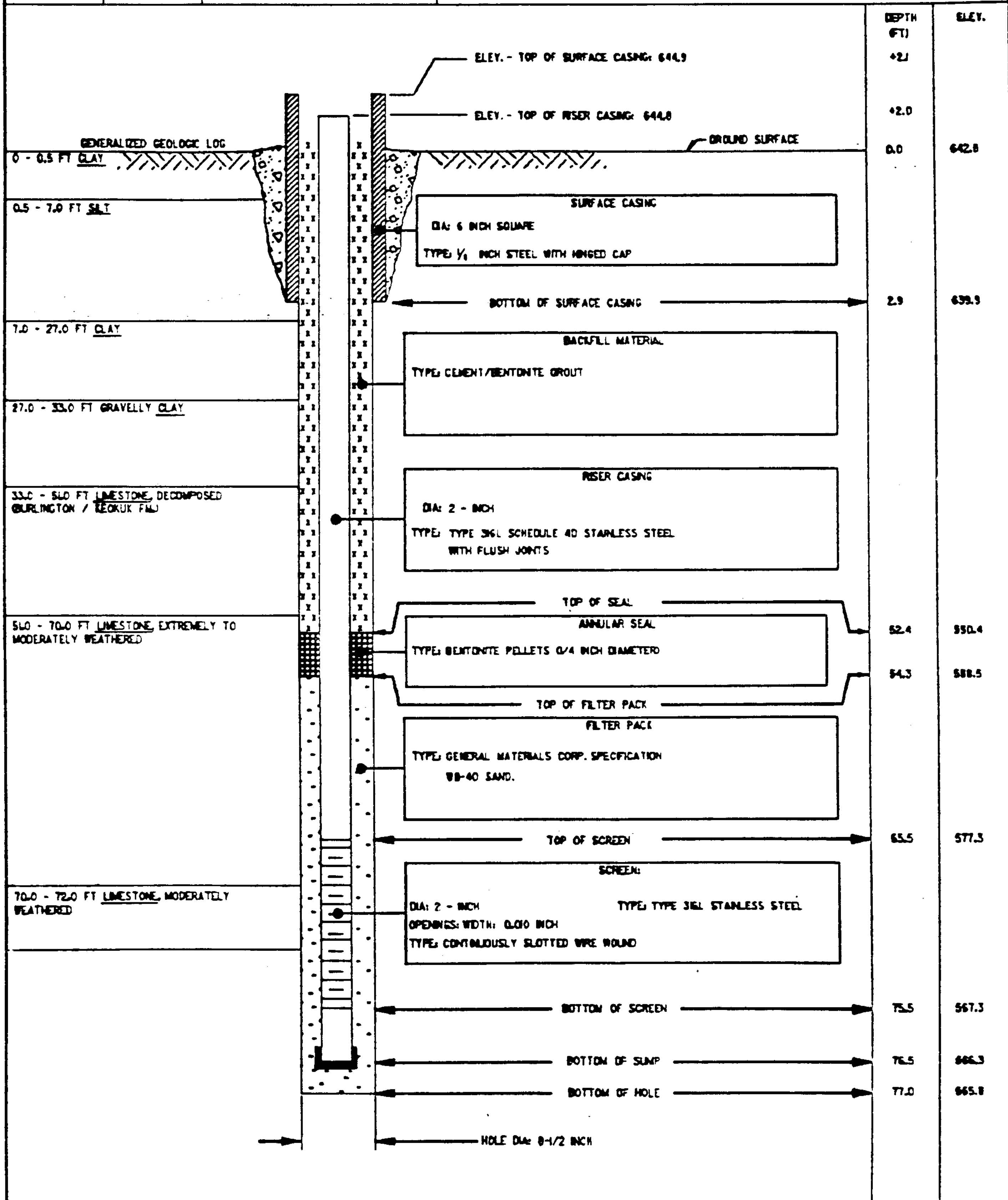
FILTER PACK
TYPE: GENERAL MATERIALS CORP. SPECIFICATION #8-40 SAND.

SCREEN:
DIA: 2 - INCH TYPE: TYPE 316L STAINLESS STEEL
OPENINGS: WIDTH: 0.010 INCH
TYPE: CONTINUOUSLY SLOTTED WIRE WOUND

HOLE DIA: 8-1/2 INCH

MONITORING WELL

PROJECT	FUSRAP - WELDON SPRING CHEMICAL PLANT	WELL NO.	GMW-4
JOB NO.	14501	SITE	NORTH OF ASH POND
COORDINATES	N101,450 W51,750		
BEGUN	7/28/86	COMPLETED	7/28/86
PREPARED BY	E.BERGLUND	REFERENCE POINT FOR MEASUREMENTS	GROUND SURFACE



BECHTEL

MONITORING WELL

PROJECT	WELL NO.
FUSRAP - WELDON SPRING CHEMICAL PLANT	GMW-5

JOB NO.	SITE	COORDINATES
14501	NORTH END OF ASH POND DAM	N101,131 W51,950

BEGUN	COMPLETED	PREPARED BY	REFERENCE POINT FOR MEASUREMENTS
7/22/86	7/22/86	E.BERGLUND	GROUND SURFACE

GENERALIZED GEOLOGIC LOG

0 - 0.5 FT SILTY CLAY

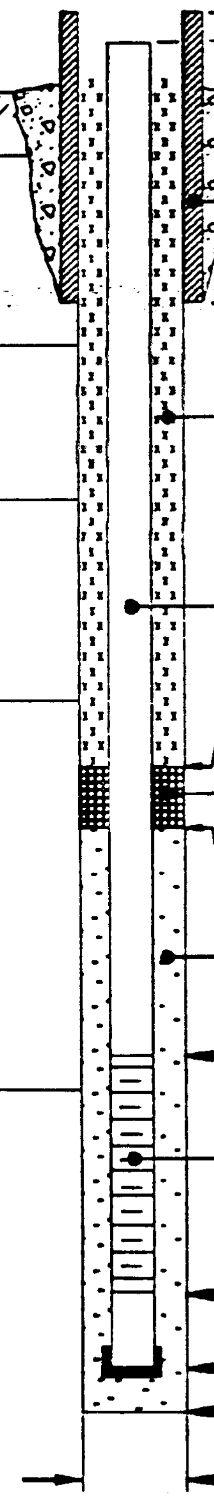
0.5 - 6.0 FT SILT

6.0 - 18.5 FT SILTY CLAY

18.5 - 44.8 FT GRAVEL AND CLAY

44.8 - 66.9 FT LIMESTONE, MODERATELY TO SEVERELY WEATHERED (BURLINGTON / KEOKUK FM.)

66.9 - 76.0 FT LIMESTONE SLIGHTLY WEATHERED



	DEPTH (FT)	ELEV.
ELEV. - TOP OF SURFACE CASING 637.8	+2.1	
ELEV. - TOP OF RISER CASING 637.7	+2.0	
GROUND SURFACE	0	635.7
BOTTOM OF SURFACE CASING	2.9	632.8
TOP OF SEAL	48.1	587.6
TOP OF FILTER PACK	50.0	585.7
TOP OF SCREEN	65.5	570.2
BOTTOM OF SCREEN	75.5	560.2
BOTTOM OF SUMP	76.5	559.2
BOTTOM OF HOLE	81.0	554.7

SURFACE CASING
DIA: 6 INCH SQUARE
TYPE: 1/4 INCH STEEL WITH HINGED CAP

BACKFILL MATERIAL
TYPE: CEMENT/BENTONITE GROUT

RISER CASING
DIA: 2 - INCH
TYPE: TYPE 316L SCHEDULE 40 STAINLESS STEEL WITH FLUSH JOINTS

ANNULAR SEAL
TYPE: BENTONITE PELLETS (1/4 INCH DIAMETER)

FILTER PACK
TYPE: GENERAL MATERIALS CORP. SPECIFICATION 30-40 SAND.

SCREEN
DIA: 2 - INCH
TYPE: TYPE 316L STAINLESS STEEL
OPENINGS: WIDTH: 0.010 INCH
TYPE: CONTINUOUSLY SLOTTED WIRE WOUND

HOLE DIA: 8-1/2 INCH

MONITORING WELL

PROJECT	WELL NO.
FUSRAP - WELDON SPRING CHEMICAL PLANT	GMW-6

JOB NO.	SITE	COORDINATES
14501	WEST OF FROG POND	N101,223 W49,852

BEGUN	COMPLETED	PREPARED BY	REFERENCE POINT FOR MEASUREMENTS
7/18/86	7/21/86	E.BERGLUND	GROUND SURFACE

GENERALIZED GEOLOGIC LOG

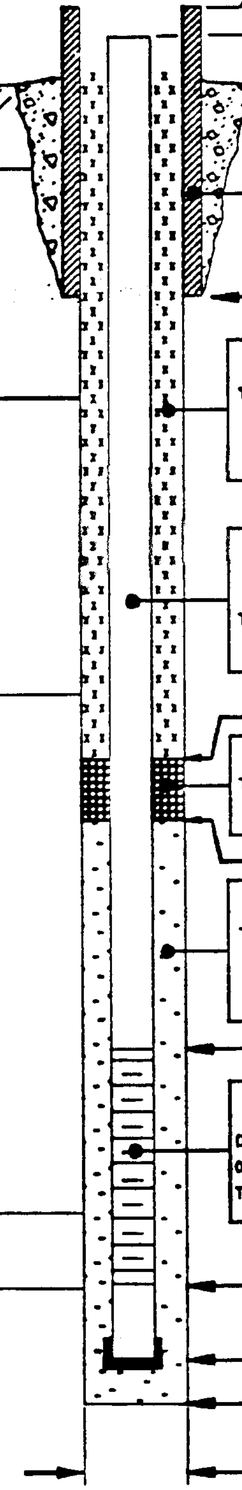
0 - 0.5 FT GRAVEL AND CLAY

0.5 - 11.0 FT SILTY CLAY

11.0 TO 22.6 FT GRAVELLY CLAY

22.6 - 58.1 FT LIMESTONE, MODERATELY TO SEVERELY WEATHERED (BURLINGTON / KEOKUK FM.)

58.1 - 65.5 FT LIMESTONE, SLIGHTLY WEATHERED



	DEPTH (FT)	ELEV.
ELEV. - TOP OF SURFACE CASING: 635.9	+2.1	
ELEV. - TOP OF RISER CASING: 635.8	+2.0	
GROUND SURFACE	0	633.8
BOTTOM OF SURFACE CASING	2.9	630.9
TOP OF SEAL	24.6	609.2
TOP OF FILTER PACK	27.0	606.8
TOP OF SCREEN	55.5	578.3
BOTTOM OF SCREEN	65.5	568.3
BOTTOM OF SUMP	66.5	567.3
BOTTOM OF HOLE	71.0	562.8

SURFACE CASING
DIA: 6 INCH SQUARE
TYPE: 1/8 INCH STEEL WITH HINGED CAP

BACKFILL MATERIAL
TYPE: CEMENT/BENTONITE GROUT

RISER CASING
DIA: 2 - INCH
TYPE: TYPE 316L SCHEDULE 40 STAINLESS STEEL WITH FLUSH JOINTS

ANNULAR SEAL
TYPE: BENTONITE PELLETS (1/4 INCH DIAMETER)

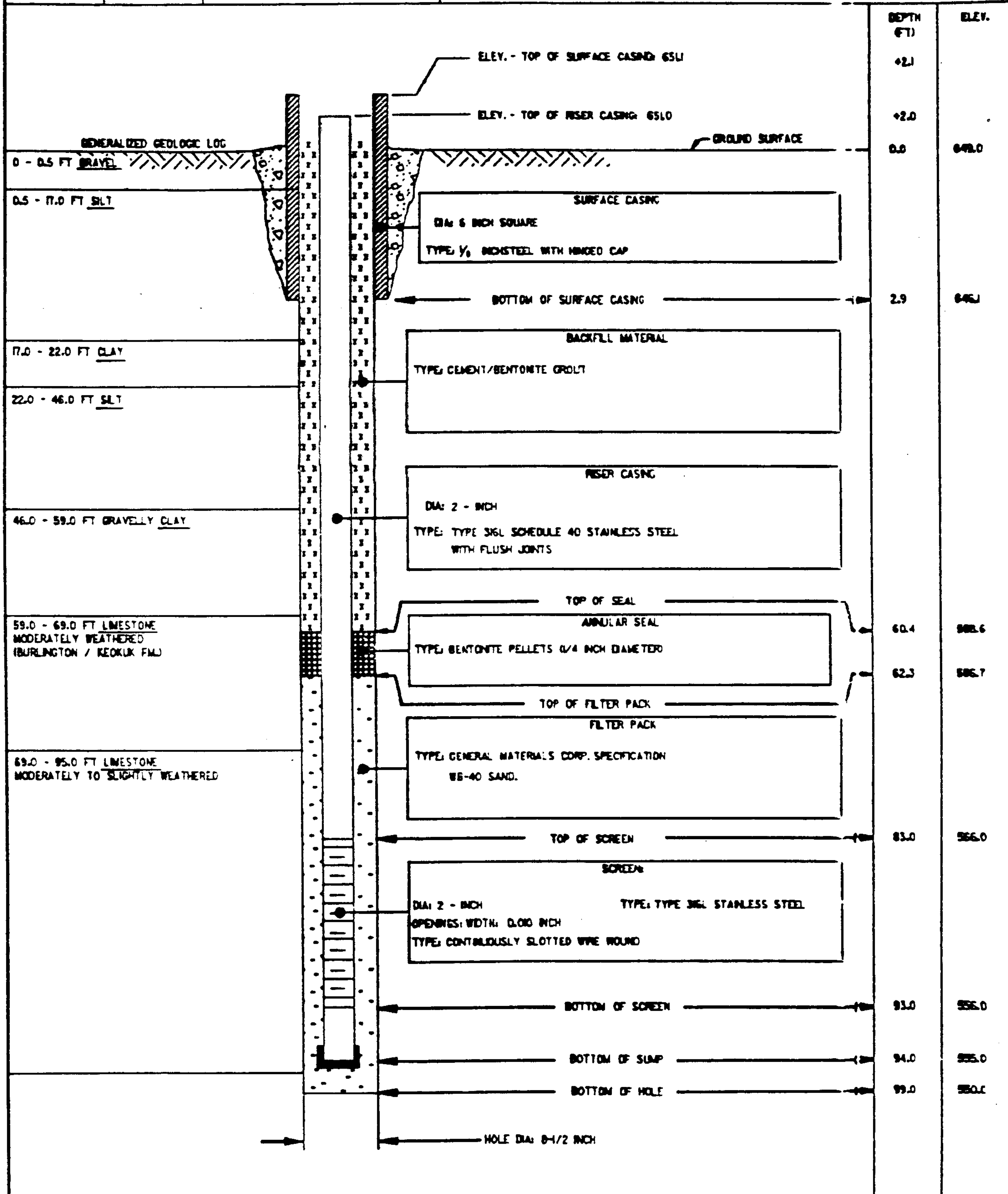
FILTER PACK
TYPE: GENERAL MATERIALS CORP. SPECIFICATION WS-40 SAND.

SCREEN:
DIA: 2 - INCH
TYPE: TYPE 316L STAINLESS STEEL
OPENINGS: WIDTH: 0.010 INCH
TYPE: CONTINUOUSLY SLOTTED WIRE WOUND

HOLE DIA: 8-1/2 INCH

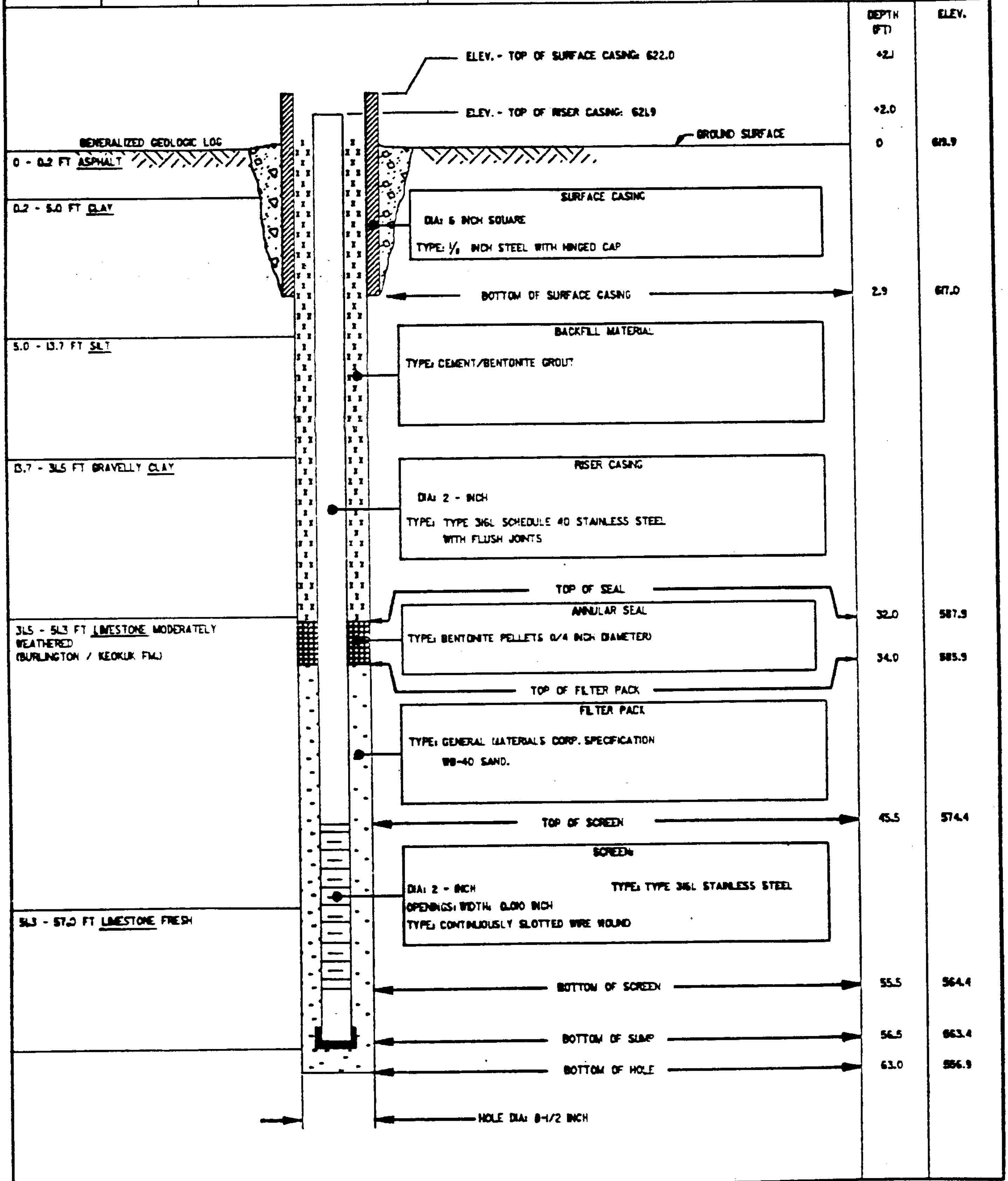
BECHTEL

MONITORING WELL	PROJECT: FUSRAP - WELDON SPRING CHEMICAL PLANT		WELL NO.: GMW-7
JOB NO.: 14501	SITE: PATROL ROAD WEST OF COAL STORAGE	COORDINATES: N100,928 W50,933	
BEGUN: 7/25/86	COMPLETED: 7/25/86	PREPARED BY: E.BERGLUND	REFERENCE POINT FOR MEASUREMENTS: GROUND SURFACE



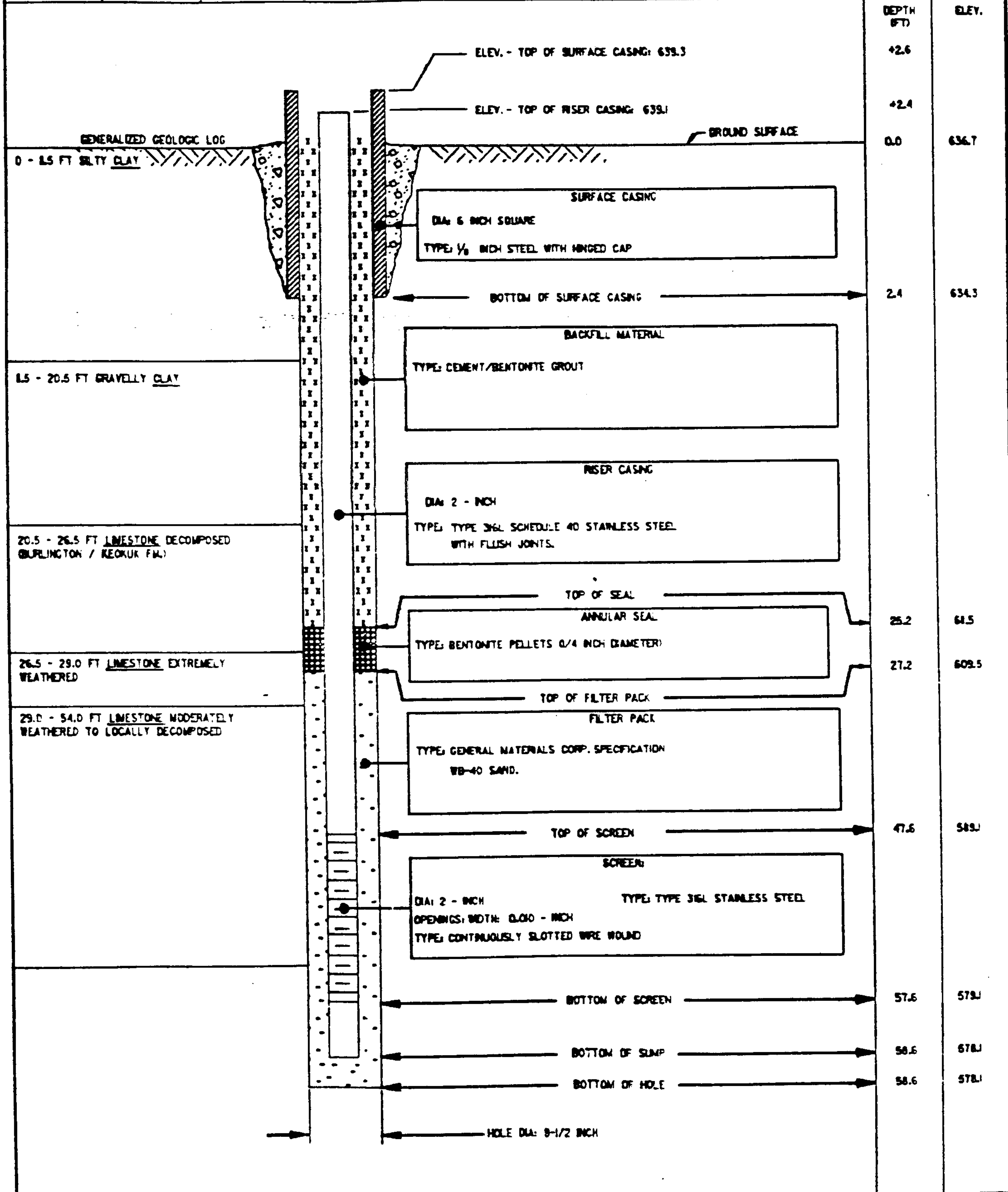
BECHTEL

# MONITORING WELL	PROJECT: FUSRAP - WELDON SPRING CHEMICAL PLANT		WELL NO. GMW-8
JOB NO. M501	SITE: NORTH OF COAL STORAGE AREA	COORDINATES: N101,720 W50,659	
BEGUN 6/23/86	COMPLETED 7/25/86	PREPARED BY A.ATKINSON	REFERENCE POINT FOR MEASUREMENTS: GROUND SURFACE



OBSERVATION WELL

PROJECT	FUSRAP-WELDON SPRING CHEMICAL PLANT	WELL NO.	GMW-9
JOB NO.	14501	SITE	NORTH OF COAL STORAGE AREA
COORDINATES	N101,350 W50,700		
BEGUN	6/25/86	COMPLETED	7/16/86
PREPARED BY	A.ATKINSON	REFERENCE POINT FOR MEASUREMENTS	GROUND SURFACE

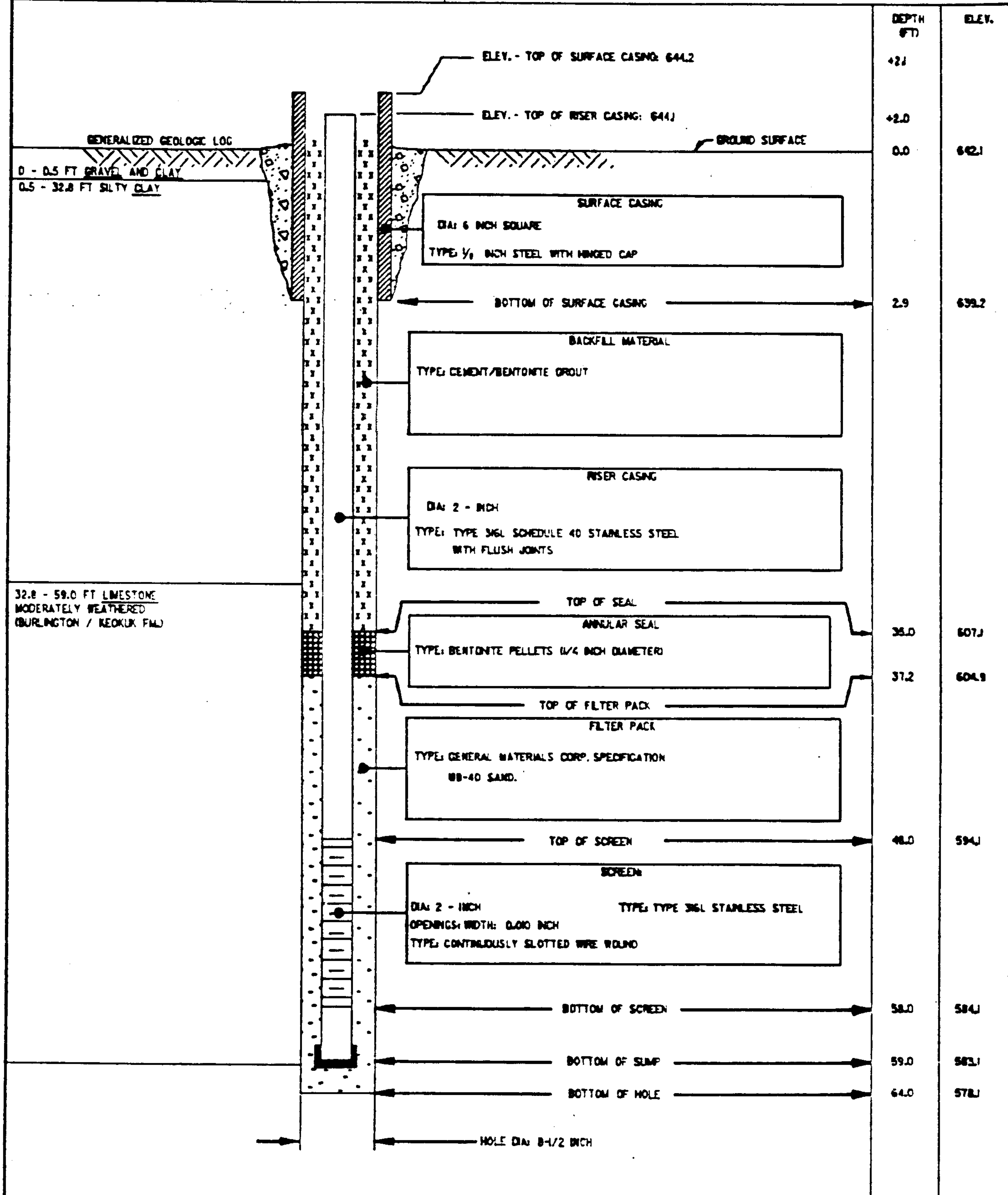


MONITORING WELL

PROJECT	WELL NO.
FUSRAP - WELDON SPRING CHEMICAL PLANT	GMW-10

JOB NO.	SITE	COORDINATES
14501	NORTH OF BUILDING 110	N101,150 W50,100

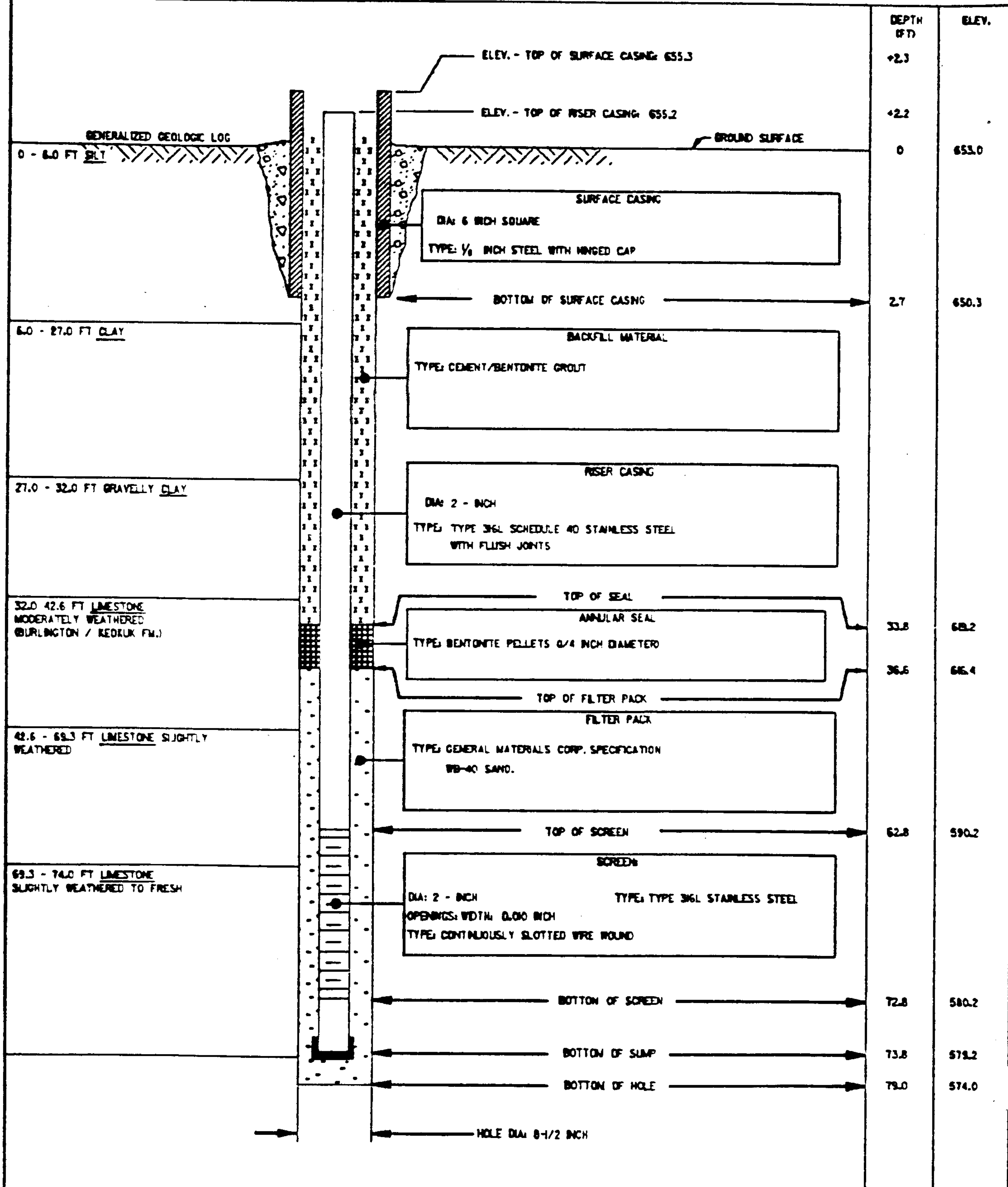
BEGUN	COMPLETED	PREPARED BY	REFERENCE POINT FOR MEASUREMENTS
7/21/86	7/21/86	E.BERGLUND	GROUND SURFACE



MONITORING WELL	PROJECT: FUSRAP - WELDON SPRING	WELL NO.: GMW-11

JOB NO.	SITE	COORDINATES
14501	EAST OF BUILDING 110	N100,916 W50,030

BEGUN	COMPLETED	PREPARED BY	REFERENCE POINT FOR MEASUREMENTS
7/18/86	7/18/86	E.BERGLUND	GROUND SURFACE

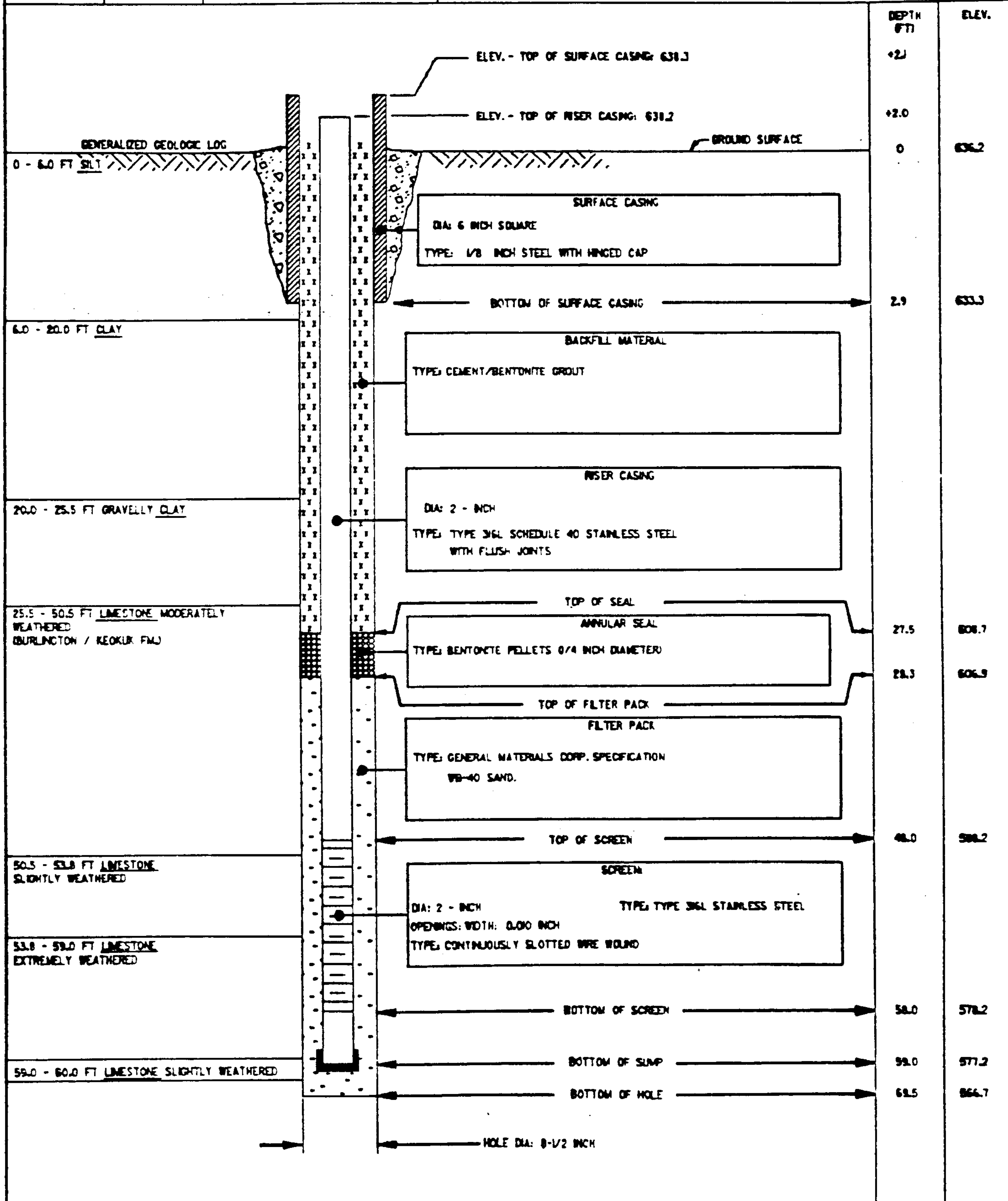


MONITORING WELL

PROJECT	WELL NO.
FUSRAP - WELDON SPRING CHEMICAL PLANT	GMW-12

JOB NO.	SITE	COORDINATES
M501	SOUTH OF FROG POND	N101,050 W49,643

BEGUN	COMPLETED	PREPARED BY	REFERENCE POINT FOR MEASUREMENTS
7/17/86	7/17/86	E.BERGLUND	GROUND SURFACE

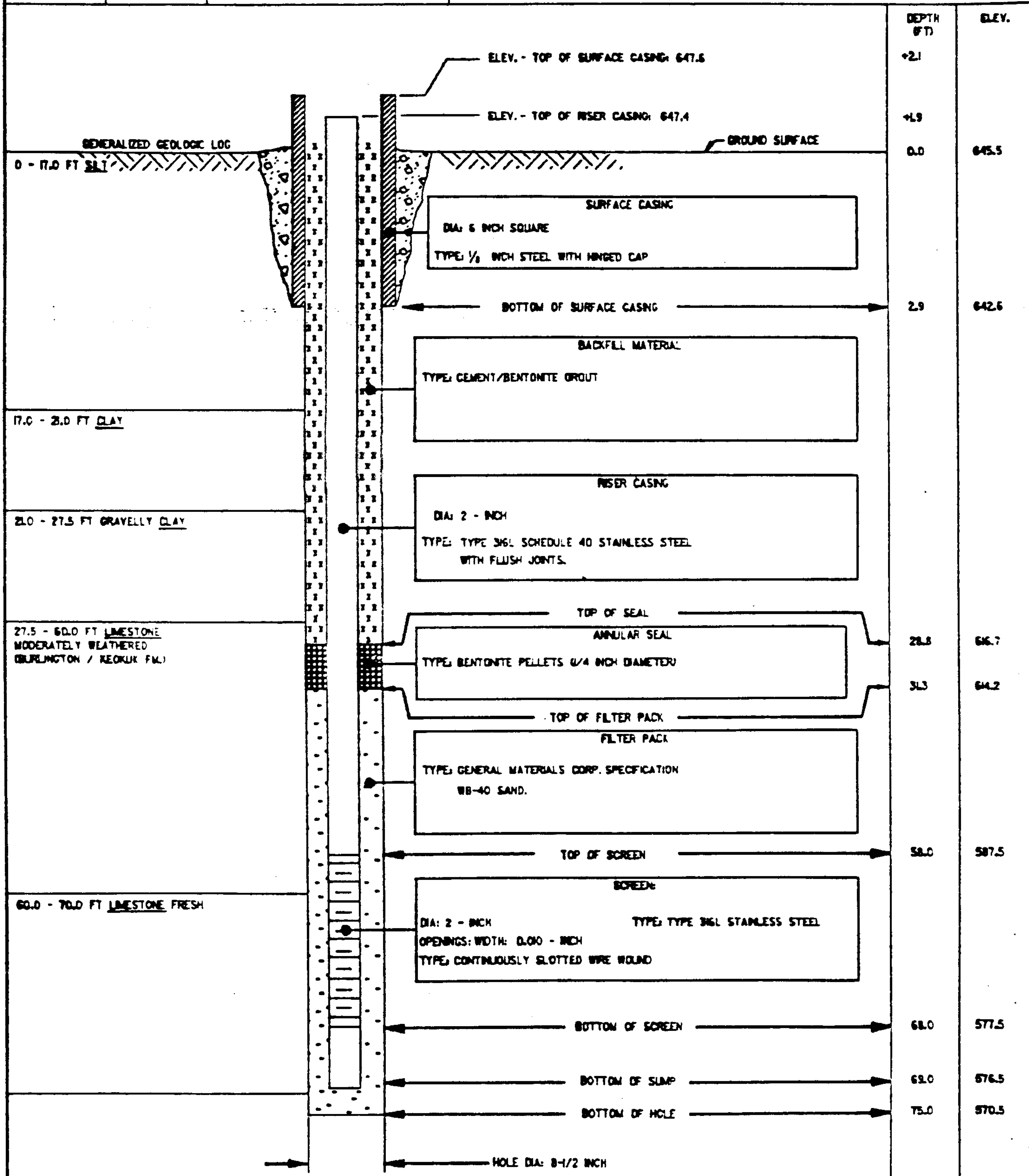


BECHTEL

OBSERVATION WELL	PROJECT: FUSRAP-WELDON SPRING CHEMICAL PLANT	WELL NO.: GMW-13

JOB NO.	SITE	COORDINATES
14501	OUTSIDE OF FENCE NE OF BUIDING 404	N100,819 W49,539

BEGUN	COMPLETED	PREPARED BY	REFERENCE POINT FOR MEASUREMENTS
6/26/86	7/16/86	A.ATKINSON	GROUND SURFACE

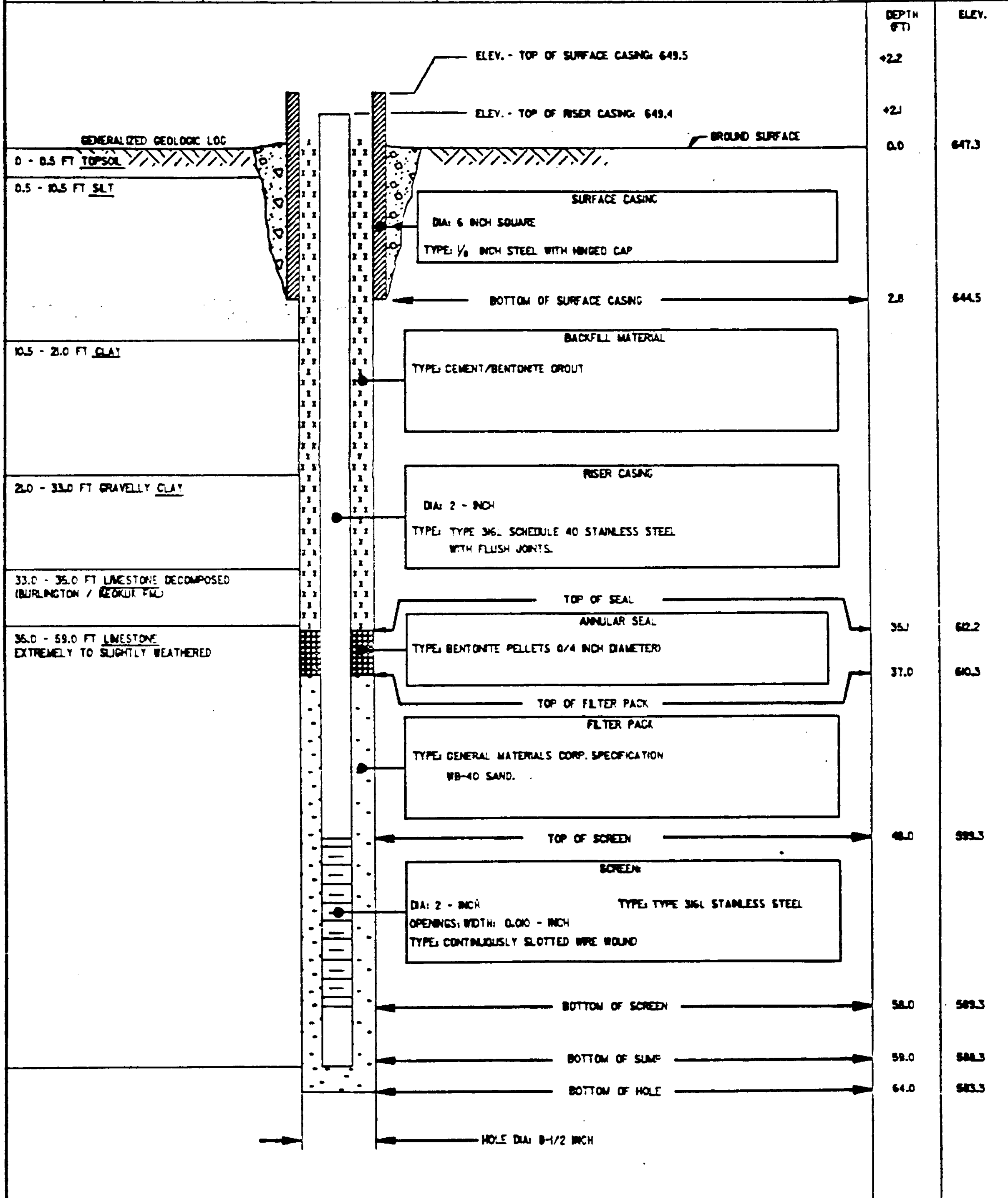


OBSERVATION WELL

PROJECT	WELL NO.
FUSRAP-WELDON SPRING CHEMICAL PLANT	GMW-14

JOB NO.	SITE	COORDINATES
14501	NE OF N PARKING LOT	N100,735 W49,186

BEGUN	COMPLETED	PREPARED BY	REFERENCE POINT FOR MEASUREMENTS
6/26/86	7/14/86	E.BERGLUND	GROUND SURFACE

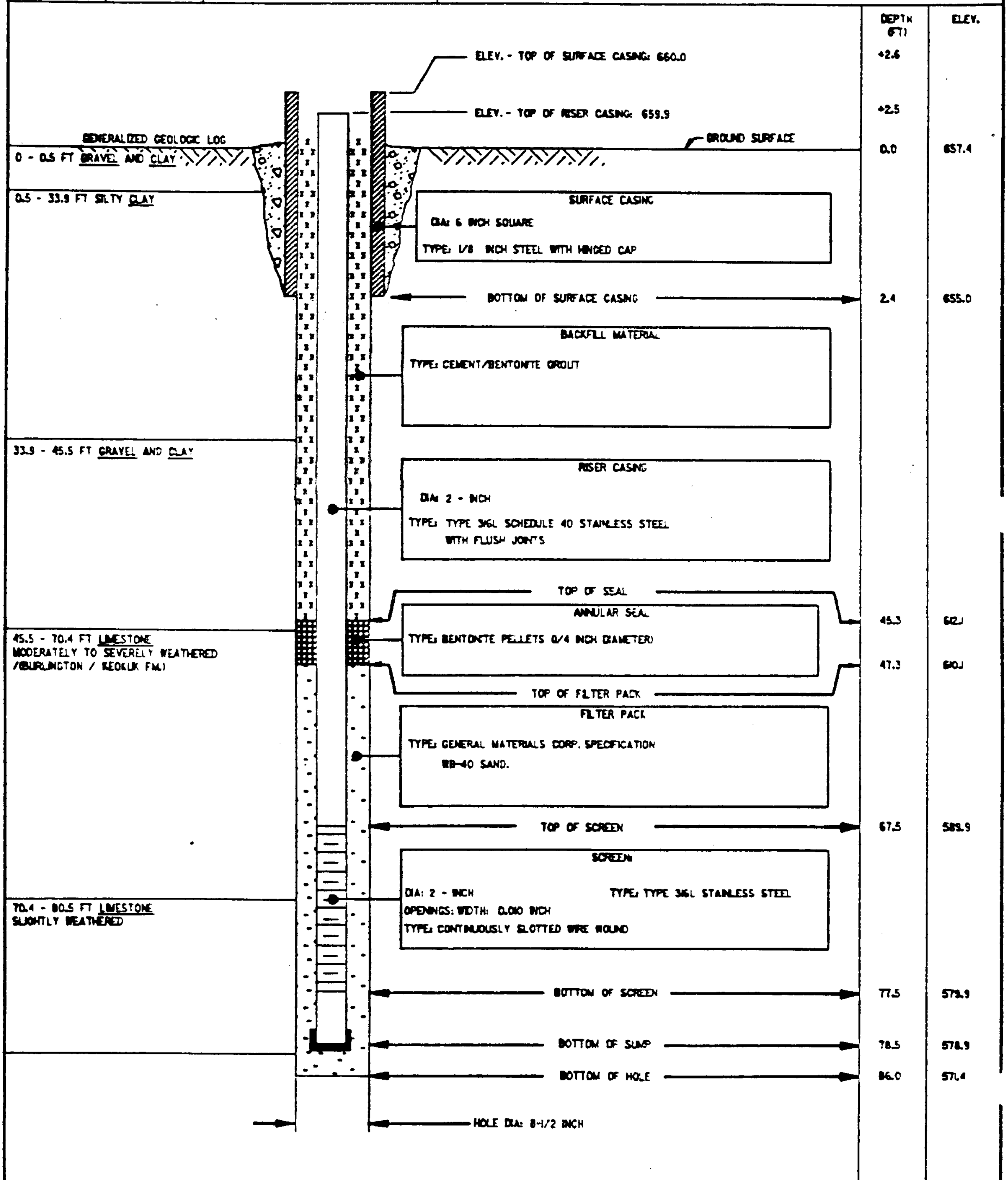


MONITORING WELL

PROJECT	WELL NO.
FUSRAP - WELDON SPRING CHEMICAL PLANT	GMW-15

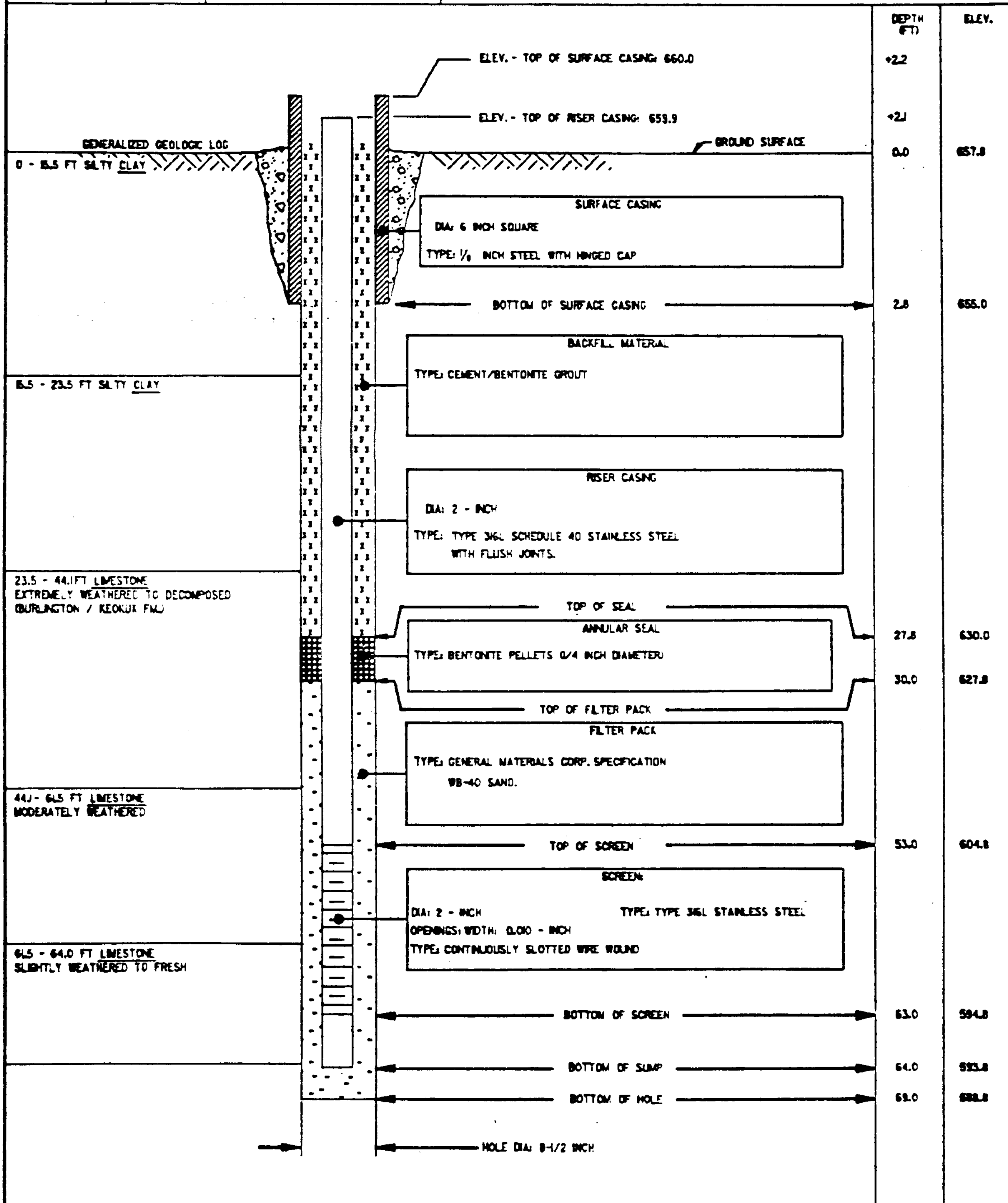
JOB NO.	SITE	COORDINATES
14501	ACROSS INTERSECTION FROM BLDG. 412	N100,100 W50,550

BEGUN	COMPLETED	PREPARED BY	REFERENCE POINT FOR MEASUREMENTS
7/28/86	7/30/86	E.BERGLUND	GROUND SURFACE

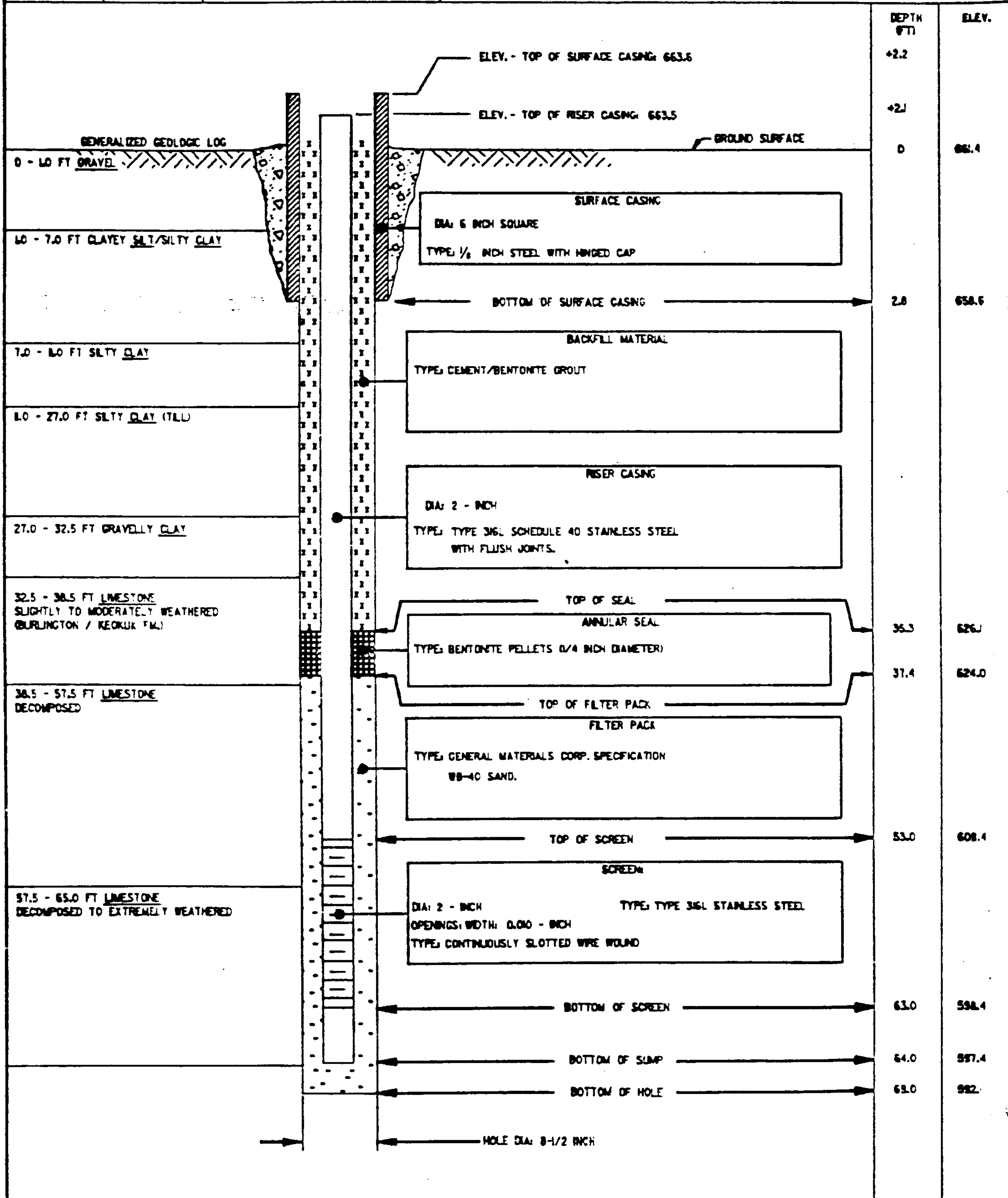


BECHTEL

OBSERVATION WELL	PROJECT: FUSRAP-WELDON SPRING CHEMICAL PLANT		WELL NO.: GMW-17
JOB NO.: 14501	SITE: MAIN ENTRANCE GATE	COORDINATES: N100,200 W49,050	
BEGUN: 6/17/86	COMPLETED: 7/15/86	PREPARED BY: A.ATKINSON	REFERENCE POINT FOR MEASUREMENTS: GROUND SURFACE



OBSERVATION WELL	PROJECT: FUSRAP-WELDON SPRING CHEMICAL PLANT		WELL NO.: GMW-18
JOB NO.: 14501	SITE: SOUTHEAST OF BLDG. 434	COORDINATES: N98,297 W50,382	
BEGUN: 6/28/86	COMPLETED: 7/16/86	PREPARED BY: A.ATKINSON	REFERENCE POINT FOR MEASUREMENTS: GROUND SURFACE



APPENDIX G
HYDROGEOCHEMICAL DATA

ENVIRODYNE
ENGINEERS

12161 Lackland Road,
St Louis, Missouri 63146
(314) 434-6960

REPORT OF ANALYSIS

CLIENT: Environmental Supervisor
FUSRAP
Bechtel National, Inc.
P.O. Box 350
Oak Ridge, Tennessee 37830

PROJ. #: 3060-00354

REPORT DATE: October 30, 1986
SAMPLE ANALYZED: 2 groundwater samples for radiological analyses.

DATE RECEIVED: September 19 & 22, 1986
P.O. #:

SAMPLE	DATE (1986)	PARAMETER	VALUE
201-SP-B21-0386	9/20	GROSS ALPHA, pCi/l	12 +/- 4
		GROSS BETA, pCi/l	12 +/- 3
		TOTAL URANIUM, mg/l	0.018
		RADIUM-226, pCi/l	< 0.6
		URANIUM-234, pCi/l	6.4 +/- 1.6
		URANIUM-235, pCi/l	< 0.6
		URANIUM-238, pCi/l	6.7 +/- 1.6
201-S-B4-G-00386	9/19	GROSS ALPHA, pCi/l	15 +/- 3
		GROSS BETA, pCi/l	5 +/- 3
		TOTAL URANIUM, mg/l	0.021
		RADIUM-226, pCi/l	< 0.6
		URANIUM-234, pCi/l	5.3 +/- 1.4
		URANIUM-235, pCi/l	< 0.6
		URANIUM-238, pCi/l	7.7 +/- 1.7

APPROVED: John J. Cawley

ENVIRODYNE
ENGINEERS

[illegible]
Revised July 14, 1987

REPORT OF ANALYSIS

CLIENT: Mr. Jack Blanke
Bechtel National, Inc.
Post Office Box 350
Oak Ridge, TN 37830

REPORT DATE: November 24, 1986
SAMPLE ANALYZED: 13 Water Samples

DATE RECEIVED: October 1, 1986
P.O. #:

PROJ. #: 3060-00354

SAMPLE	ANALYSIS	RESULT
201-SP-GMW2-G-386	Conductivity(uMhos/cm)	1601.6
	pH	7.35
	Chloride(mg/L)	7.9
	Sulfate(mg/L)	64
	Carbonate(mg/L)	< 0.5
	Bicarbonate(mg/L)	49.6
	Nitrite(mg/L)	0.82
	Nitrate(mg/L)	167
	Calcium(mg/L)	210
	Magnesium(mg/L)	5.45
	Sodium(mg/L)	70.2
	Molybdenum(mg/L)	< 0.05
	Potassium(mg/L)	17.54
	Strontium(mg/L)	0.610
	Lithium(mg/L)	0.21
	Vanadium(mg/L)	< 0.050
	Hardness(mg/L,CaCO3)	547
	Oxidation-Reduction Poteneial(mv)	333
201-SP-GMW3-G-386	Conductivity(uMhos/cm)	2551.4
	pH	7.81
	Chloride(mg/L)	13
	Sulfate(mg/L)	210
	Carbonate(mg/L)	< 0.5
	Bicarbonate(mg/L)	237.8
	Nitrite(mg/L)	< 0.05
	Nitrate(mg/L)	236
	Calcium(mg/L)	235
	Magnesium(mg/L)	84.6
	Sodium(mg/L)	57.2
	Molybdenum(mg/L)	< 0.05
	Potassium(mg/L)	10.54
	Strontium(mg/L)	0.723
	Lithium(mg/L)	0.45
	Vanadium(mg/L)	0.025
	Hardness(mg/L,CaCO3)	962
	Oxidation-Reduction Poteneial(mv)	308

ENVIRODYNE
ENGINEERS

REPORT OF ANALYSIS

CLIENT: Mr. Jack Blanke
Bechtel National, Inc.
Post Office Box 350
Oak Ridge, TN 37830

REPORT DATE: November 24, 1986
SAMPLE ANALYZED: 13 Water Samples

DATE RECEIVED: October 1, 1986
P.O. #:

PROJ. #: 3060-00354

SAMPLE	ANALYSIS	RESULT
201-SP-GMW4-G-386	Conductivity(uMhos/cm)	619.9
	pH	7.81
	Chloride(mg/L)	4
	Sulfate(mg/L)	13
	Carbonate(mg/L)	< 0.5
	Bicarbonate(mg/L)	350
	Nitrite(mg/L)	< 0.05
	Nitrate(mg/L)	1.20
	Calcium(mg/L)	59.2
	Magnesium(mg/L)	39.6
	Sodium(mg/L)	14.4
	Molybdenum(mg/L)	< 0.05
	Potassium(mg/L)	1.76
	Strontium(mg/L)	0.305
	Lithium(mg/L)	< 0.03
	Vanadium(mg/L)	0.084
	Hardness(mg/L,CaCO3)	320
	Oxidation-Reduction Poteneial(mv)	229
201-SP-GMW5-G-386	Conductivity(uMhos/cm)	1794.7
	pH	7.64
	Chloride(mg/L)	9.6
	Sulfate(mg/L)	76
	Carbonate(mg/L)	< 0.5
	Bicarbonate(mg/L)	83.2
	Nitrite(mg/L)	< 0.05
	Nitrate(mg/L)	185
	Calcium(mg/L)	182
	Magnesium(mg/L)	49.0
	Sodium(mg/L)	71.5
	Molybdenum(mg/L)	< 0.05
	Potassium(mg/L)	9.96
	Strontium(mg/L)	0.722
	Lithium(mg/L)	0.27
	Vanadium(mg/L)	< 0.050
	Hardness(mg/L,CaCO3)	656
	Oxidation-Reduction Poteneial(mv)	321

ENVIRODYNE ENGINEERS

REPORT OF ANALYSIS

CLIENT: Mr. Jack Blanke
Bechtel National, Inc.
Post Office Box 350
Oak Ridge, TN 37830

REPORT DATE: November 24, 1986
SAMPLE ANALYZED: 13 Water Samples

DATE RECEIVED: October 1, 1986
P.O. #:

PROJ. #: 3060-00354

SAMPLE	ANALYSIS	RESULT
201-SP-GMW8-G-386	Conductivity(uMhos/cm)	6837.0
	pH	7.76
	Chloride(mg/L)	50.4
	Sulfate(mg/L)	59
	Carbonate(mg/L)	< 0.5
	Bicarnonate(mg/L)	271
	Nitrite(mg/L)	< 0.05
	Nitrate(mg/L)	< 0.05
	Calcium(mg/L)	83.1
	Magnesium(mg/L)	33.1
	Sodium(mg/L)	18.0
	Molybdenum(mg/L)	< 0.05
	Potassium(mg/L)	3.13
	Strontium(mg/L)	0.246
	Lithium(mg/L)	< 0.03
	Vanadium(mg/L)	< 0.050
	Hardness(mg/L,CaCO3)	356
	Oxidation-Reduction Poteneial(mv)	296
201-SP-RP1-W-386	Conductivity(uMhos/cm)	3515.8
	Ph	8.01
	Chloride(mg/L)	27.2
	Sulfate(mg/L)	315
	Carbonate(mg/L)	< 0.5
	Bicarbonate	50.8
	Nitrite(mg/L)	1.78
	Nitrate(mg/L)	404
	Calcium(mg/L)	361
	Magnesium(mg/L)	19.2
	Sodium(mg/L)	420
	Molybdenum(mg/L)	3.34
	Potassium(mg/L)	38.00
	Strontium(mg/L)	1.04
	Lithium(mg/L)	< 0.03
	Vanadium(mg/L)	2.38
	Hardness(mg/L,CaCO3)	936
	Oxidation-Reduction Poteneial(mv)	300

ENVIRODYNE
ENGINEERS

REPORT OF ANALYSIS

CLIENT: Mr. Jack Blanke
Bechtel National, Inc.
Post Office Box 350
Oak Ridge, TN 37830

REPORT DATE: November 24, 1986
SAMPLE ANALYZED: 13 Water Samples

DATE RECEIVED: October 1, 1986
PROJ. #: 3060-00354
P.O. #:

SAMPLE	ANALYSIS	RESULT
201-SP-RP2-W-386	Conductivity(uMhos/cm)	425.5
	pH	8.63
	Chloride(mg/L)	6.2
	Sulfate(mg/L)	796
	Carbonate(mg/L)	< 0.5
	Bicarbonate(mg/L)	39
	Nitrite(mg/L)	0.55
	Nitrate(mg/L)	10.13
	Calcium(mg/L)	101
	Magnesium(mg/L)	46.9
	Sodium(mg/L)	78
	Molybdenum(mg/L)	6.67
	Potassium(mg/L)	20.00
	Strontium(mg/L)	0.353
	Lithium(mg/L)	< 0.03
	Vanadium(mg/L)	1.41
	Hardness(mg/L,CaCO3)	470
	Oxidation-Reduction Poteneial(mv)	278
201-SP-RP3-W-386	Conductivity(uMhos/cm)	9449.5
	pH	8.06
	Chloride(mg/L)	36.3
	Sulfate(mg/L)	495
	Carbonate(mg/L)	< 0.5
	Bicarbonate(mg/L)	50
	Nitrite(mg/L)	2.69
	Nitrate(mg/L)	1170
	Calcium(mg/L)	420
	Magnesium(mg/L)	311
	Sodium(mg/L)	767
	Molybdenum(mg/L)	3.96
	Potassium(mg/L)	105.95
	Strontium(mg/L)	1.76
	Lithium(mg/L)	2.79
	Vanadium(mg/L)	0.548
	Hardness(mg/L,CaCO3)	2461
	Oxidation-Reduction Poteneial(mv)	354

ENVIRODYNE
ENGINEERS

REPORT OF ANALYSIS

CLIENT: Mr. Jack Blanke
Bechtel National, Inc.
Post Office Box 350
Oak Ridge, TN 37830

REPORT DATE: November 24, 1986
SAMPLE ANALYZED: 13 Water Samples

DATE RECEIVED: October 1, 1986

PROJ. #: 3060-00354
P.O. #:

SAMPLE	ANALYSIS	RESULT
201-SP-B2-G-386	Conductivity(uMhos/cm)	977.1
	pH	7.90
	Chloride(mg/L)	4
	Sulfate(mg/L)	26
	Carbonate(mg/L)	< 0.5
	Bicarbonate(mg/L)	128.6
	Nitrite(mg/L)	< 0.05
	Nitrate(mg/L)	88.8
	Calcium(mg/L)	102
	Magnesium(mg/L)	53.9
	Sodium(mg/L)	19.4
	Molybdenum(mg/L)	< 0.05
	Potassium(mg/L)	1.24
	Strontium(mg/L)	0.212
	Lithium(mg/L)	< 0.03
	Vanadium(mg/L)	< 0.050
	Hardness(mg/L,CaCO3)	493
	Oxidation-Reduction Poteneial(mv)	298
201-SP-B19A-G-386	Conductivity(uMhos/cm)	7368.4
	pH	7.17
	Chloride(mg/L)	22.1
	Sulfate(mg/L)	57
	Carbonate(mg/L)	< 0.5
	Bicarbonate(mg/L)	251.6
	Nitrite(mg/L)	0.06
	Nitrate(mg/L)	870
	Calcium(mg/L)	951
	Magnesium(mg/L)	250
	Sodium(mg/L)	284
	Molybdenum(mg/L)	< 0.05
	Potassium(mg/L)	3.54
	Strontium(mg/L)	2.57
	Lithium(mg/L)	0.22
	Vanadium(mg/L)	0.064
	Hardness(mg/L,CaCO3)	3448
	Oxidation-Reduction Poteneial(mv)	336

ENVIRODYNE
ENGINEERS

REPORT OF ANALYSIS

CLIENT: Mr. Jack Blanke
Bechtel National, Inc.
Post Office Box 350
Oak Ridge, TN 37830

REPORT DATE: November 24, 1986
SAMPLE ANALYZED: 13 Water Samples

DATE RECEIVED: October 1, 1986
P.O. #:

PROJ. #: 3060-00354

SAMPLE	ANALYSIS	RESULT
201-SP-GMW11-G-386	Conductivity(uMhos/cm)	5597.9
	pH	7.90
	Chloride(mg/L)	2.8
	Sulfate(mg/L)	12
	Carbonate(mg/L)	< 0.5
	Bicarbonate(mg/L)	295
	Nitrite(mg/L)	< 0.05
	Nitrate(mg/L)	4.13
	Calcium(mg/L)	61.3
	Magnesium(mg/L)	30.7
	Sodium(mg/L)	10.4
	Molybdenum(mg/L)	< 0.05
	Potassium(mg/L)	3.76
	Strontium(mg/L)	0.116
	Lithium(mg/L)	< 0.03
	Vanadium(mg/L)	< 0.050
	Hardness(mg/L,CaCO3)	438
	Oxidation-Reduction Poteneial(mv)	297
201-SP-B23-G-386	Conductivity(uMhos/cm)	7352.8
	pH	8.18
	Chloride(mg/L)	1.7
	Sulfate(mg/L)	13
	Carbonate(mg/L)	< 0.5
	Bicarbonate(mg/L)	365
	Nitrite(mg/L)	< 0.05
	Nitrate(mg/L)	1.10
	Calcium(mg/L)	47
	Magnesium(mg/L)	53.1
	Sodium(mg/L)	26.3
	Molybdenum(mg/L)	< 0.05
	Potassium(mg/L)	0.94
	Strontium(mg/L)	0.210
	Lithium(mg/L)	< 0.03
	Vanadium(mg/L)	< 0.050
	Hardness(mg/L,CaCO3)	340
	Oxidation-Reduction Poteneial(mg)	300

ENVIRODYNE
ENGINEERS

REPORT OF ANALYSIS

CLIENT: Mr. Jack Blanke
Bechtel National, Inc.
Post Office Box 350
Oak Ridge, TN 37830

REPORT DATE: November 24, 1986
SAMPLE ANALYZED: 13 Water Samples

DATE RECEIVED: October 1, 1986

PROJ. #: 3060-00354
P.O. #:

SAMPLE	ANALYSIS	RESULT
201-SP-B11-G-386	Conductivity(uMhos/cm)	450.0
	pH	8.11
	Chloride(mg/L)	6.8
	Sulfate(mg/L)	38
	Carbonate(mg/L)	< 0.5
	Bicarbonate(mg/L)	260.4
	Nitrite(mg/L)	< 0.05
	Nitrate(mg/L)	1.50
	Calcium(mg/L)	61.9
	Magnesium(mg/L)	34.5
	Sodium(mg/L)	11
	Molybdenum(mg/L)	< 0.05
	Potassium(mg/L)	1.18
	Strontium(mg/L)	0.103
	Lithium(mg/L)	< 0.03
	Vanadium(mg/L)	< 0.050
	Hardness(mg/L,CaCO3)	286
	Oxidation-Reduction Poteneial(mv)	268

Attachment I "STANDARD CLAUSES" is included herein by reference.

APPROVED:

ENVIRODYNE ENGINEERS

ATTACHMENT I - STANDARD CLAUSES

ENVIRODYNE ENGINEERS, INC.

CLIENT: Bechtel National, Inc. REPORT DATE: November 24, 1986

The testing services provided herein have been performed, findings obtained, and reports prepared in accordance with generally accepted testing laboratory principles and practices. This warrenty is in lieu of all other warrenties, either expressed or implied.

These tests were conducted in accordance with the standards and procedures specified. Interpretations of the results should take into account that there is a generally recognized and accepted degree of error associated with these and all laboratory analytical tests.

These analyses have been made (tests performed) and report prepared based upon the specific sample(s) provided to us by the client or his/her representative for testing. We assume no responsiblity for variations in quality, composition, appearance, performance, etc. or any other feature of similar subject matter produced, manufactured, fabricated, etc. by persons or under conditions over which we have no control.

Samples will not be held by the laboratory for more than 60 days after the date of receipt. Any extension of this time must be evidenced by written agreement between the laboratory and the client.

This REPORT OF ANALYSIS is furnished in strict confidence for the exclusive use of the client and his/her representatives, and no distribution of all or part of the report shall be made to third parties without the prior written approval of Envirodyne Engineers, Inc. (EEI).

ENVIRODYNE
ENGINEERS

12161 Lackland Road
St. Louis, Missouri 63146
(314) 434-6960

REPORT OF ANALYSIS

CLIENT: Environmental Supervisor
FUSRAP
Bechtel National, Inc.
P.O. Box 350
Oak Ridge, Tennessee 37830

PROJ. #: 3060-00354

REPORT DATE: November 17, 1986
SAMPLE ANALYZED: 2 Samples for radiological analysis

DATE RECEIVED: October 8, 1986
P.O. #: 14501-201-SC-171

SAMPLE 201-SP	SAMPLE DATE (1986)	PARAMETER	VALUE
B11-G-0386	10/6	GROSS ALPHA, pCi/l	< 2
		GROSS BETA, pCi/l	6 +/- 3
		TOTAL URANIUM, mg/l	0.002
		RADIUM 226, pCi/l	< 0.6
		URANIUM 234, pCi/l	1.72 +/- 0.31
		URANIUM 235, pCi/l	0.07 +/- 0.03
		URANIUM 238, pCi/l	0.50 +/- 0.20
B17-G-0386	10/6	GROSS ALPHA, pCi/l	< 2
		GROSS BETA, pCi/l	24 +/- 4
		TOTAL URANIUM, mg/l	0.006
		RADIUM 226, pCi/l	< 0.6
		URANIUM 234, pCi/l	5.00 +/- 1.70
		URANIUM 235, pCi/l	0.20 +/- 0.10
		URANIUM 238, pCi/l	1.35 +/- 0.20

APPROVED: Frederick S. Oakley

PAGE 1 OF 1

ENVIRODYNE
ENGINEERS

12161 Lackland Road
St. Louis, Missouri 6314[illegible]
(314) 434-6960

REPORT OF ANALYSIS

CLIENT: Environmental Supervisor
FUSRAP
Bechtel National, Inc.
P.O. Box 350
Oak Ridge, Tennessee 37830
PROJ. #: 3060-00354
P.O. #:

REPORT DATE: October 27, 1986
SAMPLE ANALYZED: 11 groundwater sample for radiological analysis.

DATE RECEIVED: September 23, 1986
METHODS USED: Done by CEP using EPA-Approvable methodologies.

SAMPLE 201-SP-GMW	SAMPLE DATE (1986)	PARAMETER	VALUE
12-G-00386	9/20	GROSS ALPHA, pCi/l	< 2
		GROSS BETA, pCi/l	< 3
		TOTAL URANIUM, mg/l	0.003
		RADIUM-226, pCi/l	< 0.6
14-G-00386	9/20	GROSS ALPHA, pCi/l	10 +/- 5
		GROSS BETA, pCi/l	6 +/- 3
		TOTAL URANIUM, mg/l	0.009
		RADIUM-226, pCi/l	2.2 +/- 0.8
13-G-00386	9/20	GROSS ALPHA, pCi/l	10 +/- 7
		GROSS BETA, pCi/l	8 +/- 3
		TOTAL URANIUM, mg/l	0.009
		RADIUM-226, pCi/l	2.0 +/- 0.6
10-G-00386	9/20	GROSS ALPHA, pCi/l	12 +/- 7
		GROSS BETA, pCi/l	8 +/- 3
		TOTAL URANIUM, mg/l	0.007
		RADIUM-226, pCi/l	3.3 +/- 0.6
18-G-00386	9/21	GROSS ALPHA, pCi/l	19 +/- 9
		GROSS BETA, pCi/l	23 +/- 4
		TOTAL URANIUM, mg/l	0.011
		RADIUM-226, pCi/l	5.3 +/- 0.9
15-G-00386	9/21	GROSS ALPHA, pCi/l	< 2
		GROSS BETA, pCi/l	4 +/- 3
		TOTAL URANIUM, mg/l	0.008
		RADIUM-226, pCi/l	< 0.6

ENVIRODYNE
ENGINEERS

REPORT OF ANALYSIS — PAGE 2

CLIENT: Environmental Supervisor 3060-00354
FUSRAP
Bechtel National, Inc.
P.O. Box 350
Oak Ridge, Tennessee 37830

SAMPLE 201-SP-GMW	SAMPLE DATE (1986)	PARAMETER	VALUE
7-G-00386	9/21	GROSS ALPHA, pCi/l	14 +/- 8
		GROSS BETA, pCi/l	15 +/- 3
		TOTAL URANIUM, mg/l	0.011
		RADIUM-226, pCi/l	< 0.6
9-G-00386	9/21	GROSS ALPHA, pCi/l	6 +/- 5
		GROSS BETA, pCi/l	5 +/- 3
		TOTAL URANIUM, mg/l	0.006
		RADIUM-226, pCi/l	< 0.6
1-G-00386	9/21	GROSS ALPHA, pCi/l	25 +/- 9
		GROSS BETA, pCi/l	18 +/- 4
		TOTAL URANIUM, mg/l	0.011
		RADIUM-226, pCi/l	3.5 +/- 0.8
6-G-00386	9/21	GROSS ALPHA, pCi/l	< 2
		GROSS BETA, pCi/l	13 +/- 3
		TOTAL URANIUM, mg/l	0.004
		RADIUM-226, pCi/l	< 0.6
21-G-00386	9/20	GROSS ALPHA, pCi/l	9 +/- 4
		GROSS BETA, pCi/l	12 +/- 3
		TOTAL URANIUM, mg/l	0.026
		RADIUM-226, pCi/l	< 0.6

APPROVED: John J. Cowzler

Transmitted 11-13-86

ALBUQUERQUE LABORATORY

CUSTOMER Bechtel National, Inc.-Weldon Springs (WISS)
ATTENTION Jeff Brown
ADDRESS P.O. Box 350
CITY Oak Ridge, TN 37830
W.O. NO. E-6275

RECEIVED NOV 12 1986

REPORT OF ANALYSIS

Radiochemical analysis of water — TYPE OF ANALYSIS

23-831 — CUSTOMER ORDER NUMBER

SAMPLES RECEIVED 10/2/86

Customer Identification	Date Collected	Type of Analysis	Total Vol. (ml)	ug/l	pCi/l
201-SP-GMW2-G-386	9/30/86	Dis-Gross Alpha	4270		<5
		Dis-Gross Beta			26±7
		Dis-Uranium		<5	
		Dis-Ra-226			0.3±0.1
201-SP-GWM3-G-386	"	Dis-Gross Alpha	2990		<5
		Dis-Gross Beta			20±8
		Dis-Uranium		<5	
		Dis-Ra-226			0.5±0.1
201-SP-GWM4-G-386	"	Dis-Gross Alpha	4150		<5
		Dis-Gross Beta			<5
		Dis-Uranium		<5	
		Dis-Ra-226			0.3±0.1
201-SP-GWM5-G-386	"	Dis-Gross Alpha	4290		<5
		Dis-Gross Beta			21±8
		Dis-Uranium		<5	
		Dis-Ra-226			0.5±0.1
201-SP-GWM8-G-386	"	Dis-Gross Alpha	4250		<5
		Dis-Gross Beta			17±7
		Dis-Uranium		<5	
		Dis-Ra-226			<0.1
201-SP-RP1-W-386	"	Dis-Gross Alpha	4000		190±40
		Dis-Gross Beta			91±12
		Dis-Uranium		41	
		Dis-Ra-226			57±6
201-SP-RP2-W-386	"	Dis-Gross Alpha	2870		590±50
		Dis-Gross Beta			250±20
		Dis-Uranium		130	
		Dis-Ra-226			40±4
201-SP-RP3-W-386		Dis-Gross Alpha	3810		230±50
		Dis-Gross Beta			410±30
		Dis-Uranium		130	
		Dis-Ra-226			120±10

REPORTED VIA TELEPHONE

PAGE 1 OF PAG

R. Melgard

11/12/86

DAT

TMA Eberline
Thermo Analytical Inc.
7021 PAN AMERICAN FREEWAY, N.E.
ALBUQUERQUE, NEW MEXICO 87109
PHONE (505) 345-3461

APPROVED BY Rod Melgard, Mgr.

ALBUQUERQUE LABORATORY

REPORT OF ANALYSIS

CUSTOMER Bechtel National, Inc.-Weldon Springs
ATTENTION Jeff Brown
ADDRESS P.O. Box 350
CITY Oak Ridge, TN 37830
V.O. NO. E-6243

TYPE OF ANALYSIS Total Uranium, Gross Alpha, Beta, Isotopic Uranium, Radium-226 in water

CUSTOMER ORDER NUMBER 23-121

SAMPLES RECEIVED 9/26/86

Customer Identification	Date Collected	Type of Analysis	ug/l	pCi/l
B-4	9/19/86	Uranium	28	
		Gross Alpha		16±9
		Gross Beta		0±5
		U-234		8.5±0.7
		U-235		0.4±0.2
		U-238		7.3±0.7
		Ra-226		<0.3

RECEIVED ‘02 1986

REPORTED VIA TELEPHONE 10/1/86 by AR

R. Melgard

APPROVED BY Rod Melgard, Mgr.

DATE 10/1/86

G-15

TMA Eberline
Thermo Analytical Inc.
7021 PAN AMERICAN FREEWAY, N.E.
ALBUQUERQUE, NEW MEXICO 87109
PHONE (505) 345-3461

Transmitted 12/11/86 (WSCP)

ALBUQUERQUE LABORATORY

REPORT OF ANAL...

CUSTOMER Bechtel National, Inc.-Weldon Springs (WSCP)
ATTENTION Jeff Brown
ADDRESS P.O. Box 350
CITY Oak Ridge, TN 37830
W.O. NO. E-6354

RECEIVED DEC 10 1986

Radiochemical analysis of water
TYPE OF ANALYSIS

23-831
CUSTOMER ORDER NUMBER

SAMPLES RECEIVED 10/29/86

PARTIAL REPORT

Customer Identification	Date Collected	Type of Analysis	Total Vol. (ml)	ug/1	pCi/1
~~201-R-W2-G-Q0386~~	~~9/26/86~~	~~Uranium~~	~~4230~~	~~7~~	
~~pH 7.14~~		~~Ra-226~~			~~0.6±0.1~~
		~~Th-230~~			
201-SP-B11-G-Q0386	10/6/86	Uranium	3520	<5	
pH 7.02		Ra-226			0.3±0.1
		Gross Alpha			15±5
		Gross Beta			22±6
201-SP-B17-G-Q0386	10/6/86	Uranium	3570	7	
pH 7.10		Ra-226			0.6±0.1
		Gross Alpha			<15
		Gross Beta			76±9
~~201-R-W1-G-Q-386~~	~~9/26/86~~	~~Uranium~~	~~4250~~	~~<5~~	
~~pH 7.21~~		~~Ra-226~~			~~0.3±0.1~~
		~~Th-230~~			~~<0.3~~

REPORTED VIA TELEPHONE

TMA Eberline
Thermo Analytical Inc.
...21 PAN AMERICAN FREEWAY, N.E.
ALBUQUERQUE, NEW MEXICO 87109
PHONE (505) 345-3461

APPROVED BY Kathy Burnham for Rod Melgard, Mgr.

12/9/..

DATE

G-16

ALBUQUERQUE LABORATORY

REPORT OF ANALYSIS

CUSTOMER	Bechtel National, Inc.-Weldon Springs
ATTENTION	Jeff Brown
ADDRESS	P.O. Box 350
CITY	Oak Ridge, TN 37830
W.O. NO.	E-6275

TYPE OF ANALYSIS

CUSTOMER ORDER NUMBER

SAMPLES RECEIVED

Customer Identification	Date Collected	Type of Analysis	Total Vol. (ml)	ug/l	pCi/l
201-SP-B2-G-386	9/30/86	Dis-Gross Alpha	4290		11±6
		Dis-Gross Beta			9±7
		Dis-Uranium		26	
		Dis-Ra-226			0.6±0.1
201-SP-B19A-G-386	"	Dis-Gross Alpha	4360		<5
		Dis-Gross Beta			<5
		Dis-Uranium		5	
		Dis-Ra-226			0.2±0.1

:EPORTED VIA TELEPHONE

APPROVED BY R. Melgard
Rod Melgard, Mgr.

DATE 11/12/86

TMA Eberline
Thermo Analytical Inc.
7021 PAN AMERICAN FREEWAY, N.E.
ALBUQUERQUE, NEW MEXICO 87109
PHONE (505) 345-3461

G-14

Department of Energy
Oak Ridge Operations
Weldon Spring Site
Remedial Action Project Office
Route 2, Highway 94 South
St. Charles, Missouri 63303

January 17, 1989

ADDRESSEES

HYDROGEOLOGIC INVESTIGATIONS SAMPLING PLAN

Enclosed is Revision 0 of the "Hydrogeologic Investigations Sampling Plan" for the Weldon Spring Site. This plan has been revised to address comments received from U. S. Environmental Protection Agency and the Missouri Department of Natural Resources as indicated in the "Responsiveness Summary", also enclosed.

Sincerely,

R. R. Nelson

R. R. Nelson
Project Manager
Weldon Spring Site
Remedial Action Project

Enclosures:
As stated

LIST OF ADDRESSEES FOR LETTER DATED JANUARY 17, 1989

Ms. B. Katherine Biggs, Chief (3)
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U. S. Environmental Protection
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726 Minnesota Avenue
Kansas City, Kansas 66101

Mr. David E. Bedan (3)
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Missouri Department of Natural
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